National Park Service
U.S. Department of the Interior

Big Thicket National Preserve
Texas

BIG THICKET
NATIONAL PRESERVE

Personal Watercraft Use
Environmental Assessment

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July 2002

SUMMARY

The Big Thicket area of east Texas, often referred to as a "biological crossroads," is a transition zone where southeastern swamps, eastern deciduous forest, central plains, pine savannas, and dry sandhills meet and intermingle. The area provides habitat for rare species and favors unusual combinations of plants and animals. The Neches River is the primary drainage of the national preserve, capturing the majority of water from precipitation and overland flow. Variations in geology, climate, soils, elevation, and drainage have resulted in a rich biological diversity. The national preserve was established to ensure the preservation, conservation, and protection of a portion of this once great forest complex. The area has also been designated as an international biosphere reserve, underscoring the importance of this ecosystem.

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies for the management of personal watercraft (PWC) use at Big Thicket National Preserve in order to ensure the protection of park resources and values while offering recreational opportunities as provided for in the national preserve's enabling legislation, purpose, mission, and goals. Upon completion of this process in accordance with the National Environmental Policy Act (NEPA), the National Park Service (NPS) may either take action to adopt special regulations to manage PWC use, or it may discontinue PWC use at this park unit.

BACKGROUND

More than one million personal watercraft are estimated to be in operation today in the United States. Sometimes referred to as "Jet skis" or "wet bikes," these vessels use an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. They are used for enjoyment, particularly for stunt-like maneuvers, and they are designed for speeds up to 70 mph. PWC recreation is the fastest growing segment of the boating industry, representing over one-third of total sales. While PWC use remains a relatively new recreational activity, it has occurred in 32 of the 87 national park system units that allow motorized boating.

After studies in Everglades National Park showed that PWC use resulted in damage to vegetation, adversely impacted shorebirds, and disturbed the life cycles of other wildlife, the National Park Service prohibited PWC use by a special regulation at the park in 1994. In recognition of its duties under its Organic Act and NPS *Management Policies,* as well as increased awareness and public controversy about PWC use, the National Park Service subsequently reevaluated its methods of PWC regulation. Historically, the National Park Service had grouped personal watercraft with all vessels; thus, PWC use was allowed when the unit's superintendent's compendium allowed the use of other vessels. Later the Park Service closed seven units to PWC use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park.

In May 1998 the Bluewater Network filed a petition urging the National Park Service to initiate a rulemaking process to prohibit PWC use throughout the national park system. In response to the petition, the Park Service issued an interim management policy requiring superintendents of parks where PWC use can occur but had not yet occurred to close the unit to such use until the rule was finalized. The Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts from PWC use before authorizing the use. On March 21, 2000, the National Park Service issued a regulation prohibiting PWC use in most units and required 21 units to determine the appropriateness of continued PWC use.

In response to the PWC final regulation, Bluewater Network sued the National Park Service, challenging the National Park Service's decision to allow continued PWC use in 21 units while prohibiting PWC use in other units. In response to the suit, the National Park Service and the environmental group negotiated a settlement. While 21 units can continue PWC use in the short term, each of those parks desiring to continue long-term PWC use must promulgate a park-specific special regulation in 2002. In addition, the settlement stipulates that the National Park Service must base its decision to issue a park-specific special regulation to continue PWC use through an environmental analysis conducted in accordance with the National Environmental Policy Act (NEPA). The NEPA analysis at a minimum, according to the settlement, must evaluate PWC impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

ALTERNATIVES CONSIDERED

This environmental assessment evaluates three alternatives concerning the use of personal watercraft at Big Thicket National Preserve.

- Alternative A would continue PWC use under a special regulation in all areas where it is now allowed by the Superintendent's Compendium. All federal and state watercraft laws and regulations, including times of use, would be enforced. Personal watercraft could land on any shoreline in the area, and there would be no limits on the numbers of craft. Any type of engine would be allowed.

- Alternative B would continue PWC use under a special regulation, but PWC use in all connected oxbows and other backwater areas along the central river channels would be prohibited. PWC use in approved areas would be allowed from three hours after sunrise to one hour before sunset. All personal watercraft would have to have four-stroke engines. To educate PWC users about restrictions and safe operation, staff would provide signs at launch sites and in sensitive areas, as well as brochures, training, and education during enforcement actions. This alternative is the National Park Service's preferred alternative.

- The no-action alternative would ban all PWC use within the national preserve.

Based on the environmental analysis prepared for PWC use at Big Thicket National Preserve, alternative B is considered the environmentally preferred alternative because it would best fulfill park responsibilities as trustee of this sensitive habitat; ensure safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and attain a wider range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.

Environmental Consequences

Impacts of the three PWC management alternatives were assessed in accordance with *Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision-making.* The *Director's Order #12 Handbook* requires that impacts to park resources be analyzed in terms of their context, duration, and intensity. It is crucial for the public and decision-makers to understand the implications of those impacts in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists.

To determine impacts, methodologies were identified to measure the change in park resources that would occur with the implementation of the PWC management alternatives. Thresholds were established for each impact topic to help understand the severity and magnitude of changes in resource conditions, both adverse and beneficial.

Each PWC management alternative was compared to a baseline to determine the context, duration, and intensity of resource impacts. The baseline, for purposes of impact analysis, is the continuation of PWC use and current management projected over the next 10 years (alternative A).

Table A summarizes the results of the impact analysis for the impact topics that were assessed. The analysis considered a 10-year period (2002–2012).

TABLE A: SUMMARY OF THE IMPACT ANALYSIS

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
Water Quality			
• Impacts in the Main River Channel	Negligible to minor impacts in both 2002 and 2012. Cumulative effects: In 2002 negligible impacts for all compounds except benzene, based on the human health benchmark; moderate to potentially major impacts for benzene. The incremental impact of PWC use on the river would be minor. In 2012 impacts would be reduced to moderate because of reduced emissions.	Negligible to minor impacts in both 2002 and 2012. Cumulative effects: Similar to alternative A	Beneficial impact. Cumulative effects: similar to alternative A but no incremental contributions from PWC use.
• Impacts in Backwater Areas	Moderate to potentially major impacts in 2002 from benzene based on human health benchmarks (because of less water volume and less mixing), and minor based on ecological benchmarks. Negligible to minor impacts in 2012, assuming reduced levels of hydrocarbon emissions for both human health and ecological benchmarks. Cumulative effects: Moderate and possibly major impacts from benzene in 2002 and moderate impacts in 2012. Negligible to minor incremental contribution to these impacts from PWC use..	No impacts to aquatic biota or human health. Cumulative effects: Similar to alternative A, except no incremental contribution to impacts from PWC use, a beneficial impact to water quality.	Beneficial impact. Cumulative effects: Similar to alternative A but no incremental contributions from PWC use.
Air Quality			
• Impacts to Human Health from Airborne Pollutants	A moderate impact for ozone in 2002 and a minor impact in 2012. Negligible impacts for all other criteria pollutants. Cumulative effects: For ozone, moderate impacts while the area remained in non-attainment status; for all other pollutants, minor trending toward negligible once attainment status was achieved and improved emission controls were phased in. PWC contribution to these cumulative impacts would be very small.	Similar, but slightly reduced, impact levels compared to alternative A. Beneficial impacts from phasing in four-stroke engines because of reduced emissions. Cumulative effects: Same as alternative A, with reduced PWC contribution to these impacts.	Beneficial impact to air quality from banning PWC use. Cumulative effect: No PWC-related contribution to air quality impacts. Cumulative impacts from all other sources similar to alternative A.

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
• Impacts to Air Quality Related Values	Moderate ozone impacts on plants from 2002 through 2012, and negligible visibility impacts Cumulative effects: Moderate impacts for ozone effects on plants and minor impacts for visibility.	Similar to, but slightly reduced from, alternative A. Cumulative effects: Similar to, but slightly reduced from, alternative A.	Beneficial impact from banning PWC use. Cumulative effects: No PWC contribution to air quality impacts; other impacts the same as alternative A.
Soundscapes	Minor to moderate adverse noise impacts along the lower Neches River during times of high PWC use; minor to negligible impacts during other times. Cumulative effects: Minor to moderate adverse impacts over the next 10 years due to other noise sources (e.g., motorboats and automobile traffic). Minor incremental impact of continuing PWC use.	Compared to alternative A, reduced noise because of restrictions on times and areas of use, resulting in minor to moderate, short-term adverse impacts. Cumulative effects: Minor to moderate adverse impacts due to other noise sources. No incremental impacts from PWC use to backwater area soundscapes, but minor impacts along the river corridor.	Beneficial impact from eliminating PWC use. Cumulative effects: Minor to moderate impacts from all other sources; no incremental impacts from PWC use.
Wildlife and Wildlife Habitat	Minor to moderate direct and indirect adverse impacts from PWC-generated noise, physical disturbance, and emissions. Cumulative effects: Minor to moderate adverse impacts limited to the time during which the disturbance occurred. Negligible contribution from PWC use.	Compared to alternative A, negligible to minor adverse impacts, with some beneficial effect from reduced PWC noise at certain times and in certain locations. No impacts to wildlife in backwater areas. Cumulative effects: Similar to, but slightly less than, alternative A due to prohibiting PWC use in backwater areas and during early morning and dusk, most likely resulting in a beneficial impact.	Beneficial due to banning PWC use. Cumulative effects: Similar to alternative A from other sources of impacts; no incremental impacts from PWC Use.
Threatened or Endangered Species or Species of Special Concern	Actions may affect, but are not likely to adversely affect, any of the listed species that are likely to occur or could possibly occur in the study area. This conclusion is valid for both PWC actions alone and cumulative effects that include other actions.	Similar to alternative A except some adverse impacts would be mitigated by timing restrictions and eliminating PWC use in backwater areas.	Beneficial impact from banning PWC use. Cumulative effects from other sources of impacts would be similar to alternative A.
Shorelines and Shoreline Vegetation	Negligible impacts. Cumulative effects: Minor to moderate, depending on the level and frequency of flooding.	Negligible impacts since PWC use would be restricted to the main river channel. Beneficial impacts from banning PWC use in backwater areas. Cumulative effects: Similar to alternative A.	Beneficial effects from banning PWC use. Cumulative effects: Similar to alternative A except no PWC contribution to cumulative impacts.
Visitor Use and Experience	No impact to PWC users. Minor to moderate, long-term impacts for other park visitors. Cumulative effects: Minor, long-term impacts to overall visitor use and experience, but moderate, long-term impacts to visitors desiring to experience park resources without conflict from motorized recreational uses, including PWC use.	Minor adverse impacts on PWC users from banning use in backwater areas and limiting times of use. Minor to moderate impacts on PWC owners of non-compliant two-stroke engines; however, use of the river by other means would not be precluded. Beneficial impacts for visitors who enjoy quiet activities. Cumulative effects: Minor, long-term impacts similar to alternative A, with reduced incremental impacts from PWC use.	Minor to moderate impacts to PWC users. Beneficial impacts to other visitors desiring more passive experiences. Cumulative effects: Minor, long-term impacts since other motorized boating would continue and current PWC use is low.
Visitor Safety	Negligible impacts because of relatively safe conditions associated with low levels of PWC use. Some safety risks because all existing recreational uses would continue.	Beneficial impact from reducing the potential for accidents. Safety enhanced to a minor degree by restricting PWC use at certain times, banning PWC use in	Beneficial impacts by no longer allowing PWC use in the preserve. Cumulative effects: Minor impact from other uses that would affect visitor safety, but reduced

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
	Cumulative effects. Negligible to minor.	backwater areas, and providing educational materials. Cumulative effects: Similar to, but slightly reduced from, those for alternative A.	potential for PWC-related accidents.
Cultural Resources	Negligible impacts Cumulative effects: Minor to moderate because of impacts related to other park users.	Negligible impacts. Cumulative effects: Minor to moderate, same as alternative A.	Negligible impacts. Cumulative effects: Minor to moderate, same as alternative A.
Socioeconomic Effects	Negligible to minor economic and social impacts overall to user groups and businesses.	Minor to moderate economic and social impacts overall to user groups and businesses.	Minor to moderate economic and social impacts overall to user groups and businesses.
Preserve Management and Operations			
Conflicts with State and Local Regulations	Negligible impacts because no conflict with state PWC regulations or policies; no local regulations.	Negligible impacts, similar to alternative A.	Negligible impacts, similar to alternative A.
Preserve Operations and Increased Enforcement Needs	Negligible impacts.	Short-term, minor to moderate adverse impacts from implementing and enforcing new PWC regulations and educating visitors. Cumulative effects: minor, as more visitors became aware of the restrictions included in this alternative.	Minor to moderate, short-term impacts from enforcing the PWC ban. Slight beneficial impacts over the long term because staff would have some additional time to focus on other activities. Cumulative effects: minor, but no PWC contributions to these impacts.

No natural or cultural resources would be impaired by implementing any of the alternatives being considered.

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PURPOSE OF AND NEED FOR ACTION

Big Thicket National Preserve consists of nine land units and six water corridors encompassing more than 97,000 acres in east Texas (see Location map). The Big Thicket consists of lands with some of the richest biological diversity in North America. Natural processes have influenced the region over the millennia. Today, species from the Gulf Coastal Plains, Eastern Forests, and Central Plains share space with species indicative of swamps and bayous. Established in 1974, the preserve was added to the list of international biosphere reserves in 1981, under the UNESCO Man and the Biosphere program. In 2001 the preserve was recognized as a globally important bird area. In addition to its biological importance, Big Thicket National Preserve is also visited by thousands of people a year, who come to appreciate its natural beauty and to participate in resource-based recreational activities. Hiking, fishing, hunting, birding, photography, backcountry camping, horseback riding, off-road bicycling, canoeing, kayaking, and boating are among the activities that recreationists pursue. The first use of personal watercraft (PWC) at Big Thicket occurred in the 1980s.

More than one million personal watercraft* are estimated to be in operation today in the United States. Sometimes referred to as "Jet skis" or "wet bikes," these vessels use an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. They are used for enjoyment, particularly for stunt-like maneuvers, and they are designed for speeds up to 70 mph. PWC recreation is the fastest growing segment of the boating industry, representing over one-third of total sales.

The National Park Service (NPS) maintains that personal watercraft emerged and gained popularity in park units before it could initiate and complete a "full evaluation of the possible impacts and ramifications." While PWC use remains a relatively new recreational activity, it has occurred in 32 of the 87 park units that allow motorized boating.

The National Park Service first began to study PWC use in Everglades National Park. The studies showed that PWC use over emergent vegetation, shallow grass flats, and mud flats commonly used by feeding shorebirds damaged the vegetation, adversely impacted the shorebirds, and disturbed the life cycles of other wildlife. Consequently, managers at Everglades determined that PWC use remained inconsistent with the resources, values, and purposes for which the park was established. In 1994, the National Park Service prohibited PWC use by a special regulation at the park (59 FR 58781).

Other public entities have taken steps to limit, and even to ban, PWC use in certain waterways as national researchers study more about the effects of PWC use. At least 34 states have either implemented or have considered regulating the use and operation of personal watercraft (63 FR 49314). Similarly, various federal agencies, including the U.S. Fish and Wildlife Service and the National Oceanic and Atmospheric Agency, have managed personal watercraft differently than other classes of motorized watercraft.

Specifically, the National Oceanic and Atmospheric Agency regulate PWC use in most national marine sanctuaries. The regulation resulted in a court case where the Court of Appeals for the District

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* Personal watercraft, as defined in 36 CFR 1.4(a) (2000), refers to a vessel, usually less than 16 feet in length, which uses an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. The vessel is intended to be operated by a person or persons sitting, standing, or kneeling on the vessel, rather than within the confines of the hull. The length is measured from end to end over the deck excluding sheer, meaning a straight line measurement of the overall length from the foremost part of the vessel to the aftermost part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments, are not included in the measurement. Length is stated in feet and inches.

of Columbia declared such PWC-specific management valid. In *Personal Watercraft Industry Association v. Department of Commerce*, 48 F.3d 540 (D. C. Cir. 1995), the court ruled that an agency can discriminate and manage one type of vessel (specifically personal watercraft) differently than other vessels if the agency explains its reasons for the differentiation.

In February 1997 the Tahoe Regional Planning Agency (TRPA), the governing body charged with ensuring no derogation of Lake Tahoe's water quality, voted unanimously to ban all two-stroke, internal combustion engines, including personal watercraft, because of their effects on water quality. Lake Tahoe's ban began in 2000.

In recognition of its duties under its Organic Act and its *Management Policies*, as well as increased awareness and public controversy, the National Park Service reevaluated its methods of PWC regulation. Historically, the National Park Service had grouped personal watercraft with all vessels; thus, people could use personal watercraft when the unit's superintendent's compendium allowed the use of other vessels. Later the Park Service closed seven units to PWC use through the implementation of horsepower restrictions, general management plan revisions, and park-specific regulations such as those promulgated by Everglades National Park.

In May 1998 the Bluewater Network, a coalition of more than 70 organizations representing more than 4 million Americans, filed a petition urging the National Park Service to initiate the rulemaking process to prohibit PWC use throughout the national park system. In response to the petition, the Park Service issued an interim management policy requiring superintendents of parks where PWC use can occur but where the use had never occurred to close the unit to such use until the rule was finalized. In addition, the National Park Service proposed a specific PWC regulation premised on the notion that personal watercraft differ from conventional watercraft in terms of design, use, safety record, controversy, visitor impacts, resource impacts, horsepower to vessel length ratio, and thrust capacity (63 FR 49312–17, Sept. 15, 1998).

The National Park Service envisioned the servicewide regulation as an opportunity to evaluate impacts from PWC use before authorizing the use. The preamble to the servicewide regulation calls the regulation a "conservative approach to managing PWC use" considering the resources concerns, visitor conflicts, visitor enjoyment, and visitor safety. During a 60-day comment period the National Park Service received nearly 20,000 comments.

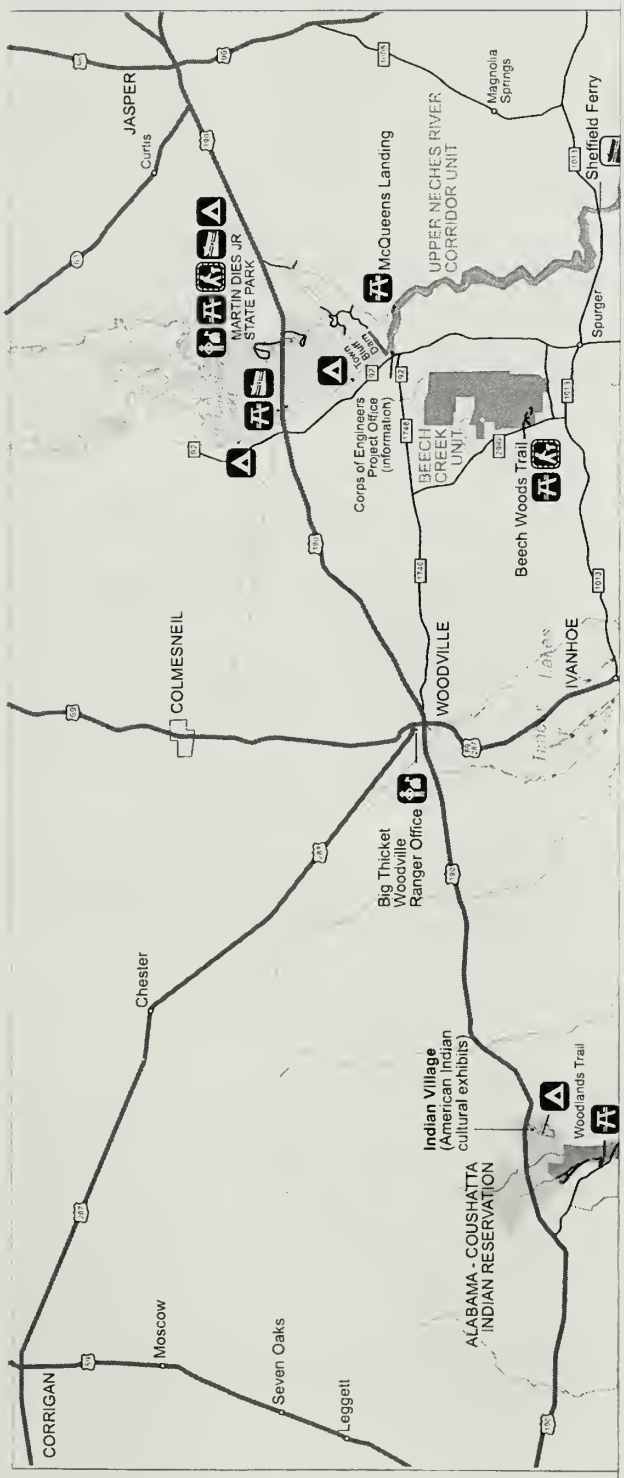
As a result of public comments and further review, the National Park Service promulgated an amended regulation that prohibited PWC use in most units and required the remaining units to determine the appropriateness of continued PWC use (36 CFR 3.24(a), 2000); 65 FR 15077–90, Mar. 21, 2000). Specifically, the regulation allowed the National Park Service to designate PWC areas and to continue their use by promulgating a special regulation in 11 units and by amending the superintendent's compendium in 10 units (36 CFR 3.24(b), 2000). The National Park Service based the distinction between designation methods on the unit's degree of motorized watercraft use.

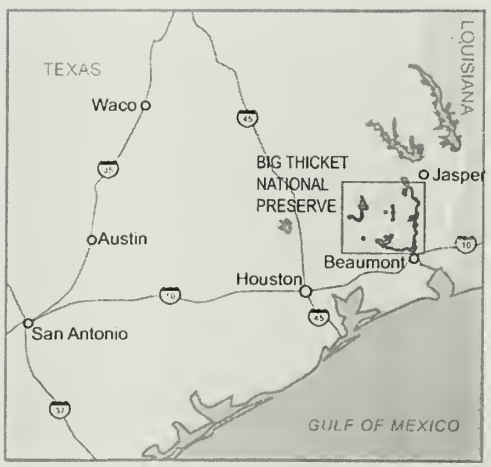
In response to the PWC final regulation, Bluewater Network sued the National Park Service under the Administrative Procedures Act and its Organic Act. The organization challenged the National Park Service's decision to allow continued PWC use in 21 units while prohibiting PWC use in other units. In addition, the organization also disputed the National Park Service's decision to allow 10 units to continue PWC use after 2002 by making entries in superintendents' compendiums, which would not require the opportunity for public input through a notice and comments on the rulemaking process.

Big Thicket National Preserve

Texas

Location

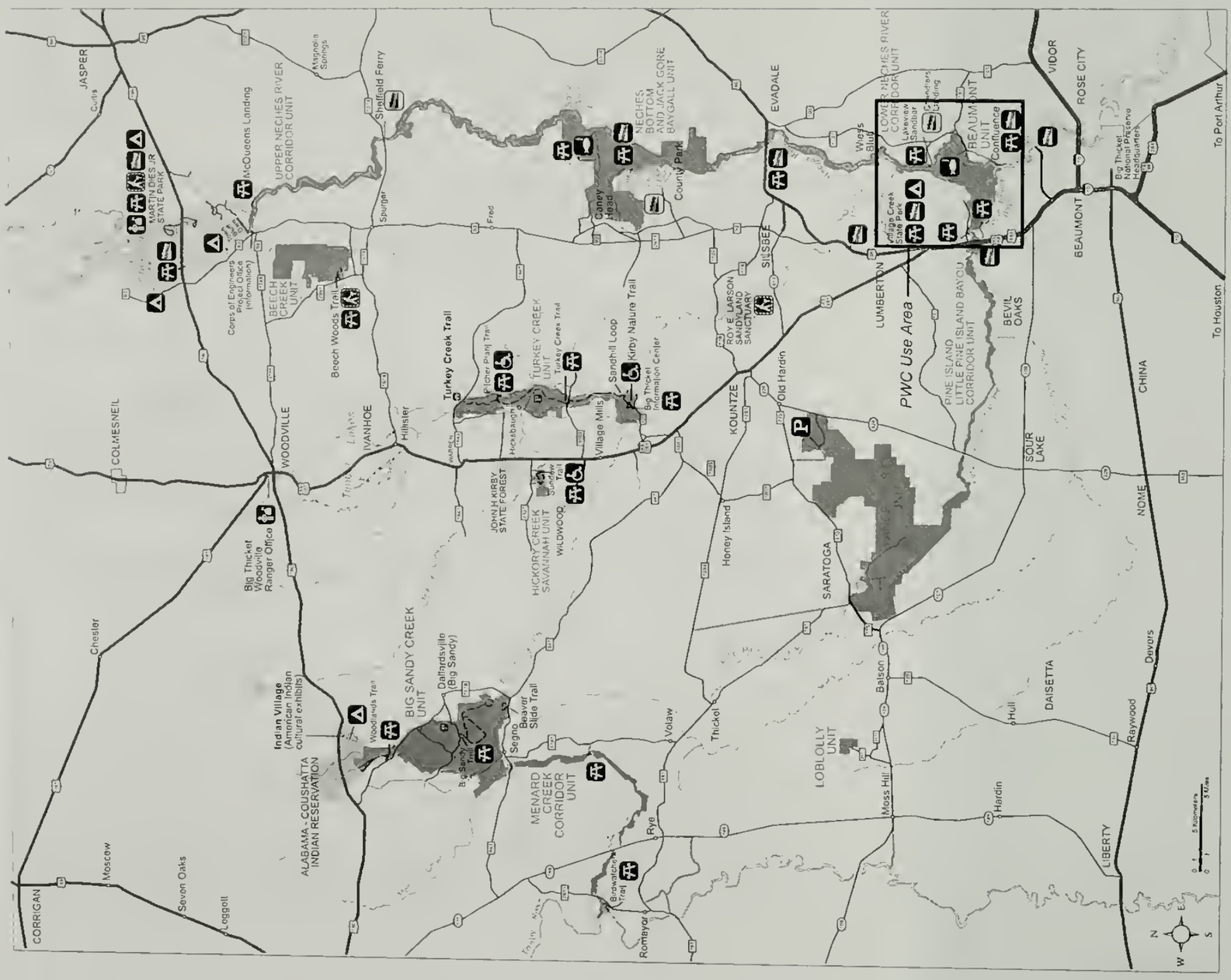




Big Thicket National Preserve

Texas

Location



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Further, the environmental group claimed that because PWC use causes water and air pollution, generates increased noise levels, and poses public safety threats, the National Park Service acted arbitrarily and capriciously when making the challenged decisions.

In response to the suit, the National Park Service and the environmental group negotiated a settlement. The resulting settlement agreement, signed by the judge on April 12, 2001, changed portions of the National Park Service's PWC rule. While 21 units can continue PWC use in the short term, each of those parks desiring to continue long-term PWC use must promulgate a park-specific special regulation in 2002. In addition, the settlement stipulates that the National Park Service must base its decision to issue a park-specific special regulation to continue PWC use through an environmental analysis conducted in accordance with the National Environmental Policy Act (NEPA). The NEPA analysis at a minimum, according to the settlement, must evaluate PWC impacts on water quality, air quality, soundscapes, wildlife, wildlife habitat, shoreline vegetation, visitor conflicts, and visitor safety.

In 2001 the National Park Service adopted its new management policy for personal watercraft. The policy prohibits PWC use in national park system units unless their use remains appropriate for the specific park unit (*Management Policies 2001*, sec. 8.2.3.3). The policy statement authorizes the use based on the park's enabling legislation, resources, values, other park uses, and overall management strategies.

PURPOSE OF AND NEED FOR ACTION

The purpose of and the need for taking action is to evaluate a range of alternatives and strategies for the management of PWC use at Big Thicket National Preserve in order to ensure the protection of park resources and values while offering recreational opportunities as provided for in the national preserve's enabling legislation, purpose, mission, and goals. Upon completion of the NEPA process, the National Park Service may either take action to adopt special regulations to manage PWC use at Big Thicket National Preserve, or it may discontinue PWC use at this park unit, as allowed for in the National Park Service March 2000 rule.

This environmental assessment evaluates three alternatives concerning the use of personal watercraft at Big Thicket National Preserve. The alternatives include two alternatives to continue PWC use under certain conditions and a no-action alternative that would prohibit PWC use.

SCOPE OF THE ANALYSIS

Motorboats and other watercraft were used in Big Thicket prior to its establishment as a national preserve in 1974; PWC use has emerged at Big Thicket only since the introduction of this form of watercraft in the 1980s (see the PWC Use Area map). While some effects of PWC use are similar to other motorcraft and therefore difficult to distinguish, the focus of this action is in support of decisions and rulemaking specific to PWC use. However, while the settlement agreement and need for action have defined the scope of this environmental assessment, the National Environmental Policy Act requires an analysis of cumulative effects on resources of all past, present, and reasonably foreseeable actions when added to the effects of the proposal (40 CFR 1508.7, 2000). The scope of this analysis, therefore, is to define management alternatives specific to PWC use, in consideration of other uses, actions, and activities cumulatively affecting park resources and values.

PURPOSE AND SIGNIFICANCE OF BIG THICKET NATIONAL PRESERVE

Congress establishes units of the national park system to fulfill specific purposes, based on an area's unique and "significant" resources. A unit's mandated purpose is the fundamental building block for its decisions to conserve resources while providing for the "enjoyment of future generations."

The enabling legislation for Big Thicket National Preserve, its purpose and significance (which are derived from its enabling legislation), and its broad mission goals, as summarized below, are taken from the national preserve's *Strategic Plan.* In addition, the park's enabling legislation, purpose, and management objectives are all linked to impairment findings that are made in the NEPA process, as stated in section 1.4.5. of the NPS *Management Policies 2001.*

Establishment

> In order to assure the preservation, conservation, and protection of the natural, scenic, and recreational values of a significant portion of the Big Thicket area . . . to provide for the enhancement and public enjoyment . . . the Big Thicket National Preserve is established (16 USC 698(a)).

Administration — Natural and Ecological Integrity

> The area . . . shall be administered . . . in a manner which will assure their natural and ecological integrity in perpetuity (16 USC 698c(a)).

Administration — Rules and Regulations for the Use of Federal Lands and Waters

> In the interest of maintaining the ecological integrity of the preserve, the Secretary shall . . . promulgate . . . such rules and regulations . . . as necessary . . . to limit and control the use of, and activities on . . . waters with respect to: motorized land and water vehicles (16 USC 698c(b)(1)).

Purpose of Big Thicket National Preserve

As stated in the national preserve's *Strategic Plan,* the purpose of the preserve is

> to protect the remnants of diverse natural biological communities and processes. The park will also allow resource-based recreation by monitoring consumptive recreational uses. Researchers will have access to park resources to obtain baseline information for research. The park will interpret and preserve the cultural history of the Big Thicket area. The National Park Service will manage and maintain the ecological integrity for perpetuity. The park will educate the public regarding the national and international importance of biological diversity.

Significance of Big Thicket National Preserve

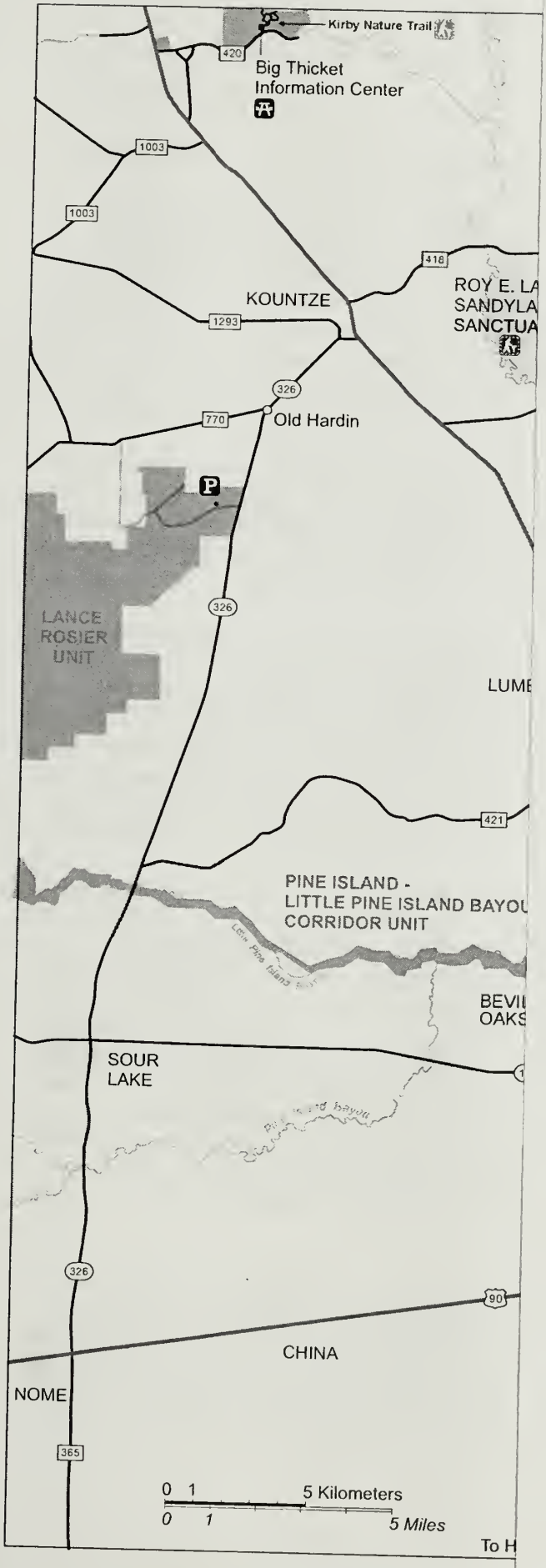
As stated in the national preserve's *Strategic Plan,* Big Thicket is significant because it

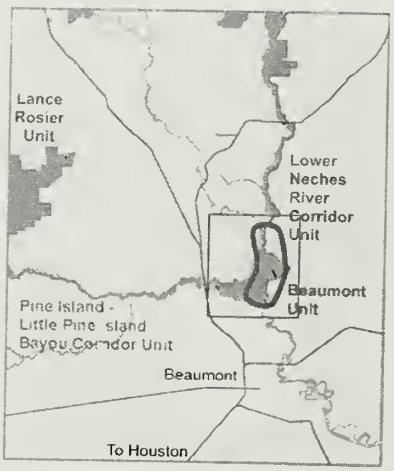
- provides habitat for protected species
- accommodates public recreation
- functions as an outdoor laboratory for research on the evolution of natural ecosystems
- facilitates educating the public about the interaction of humans with their environment

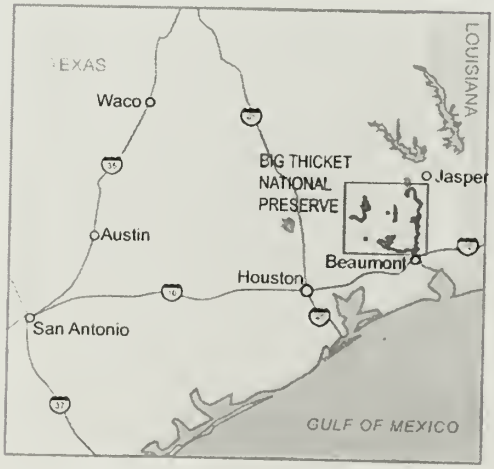
Big Thicket National Preserve

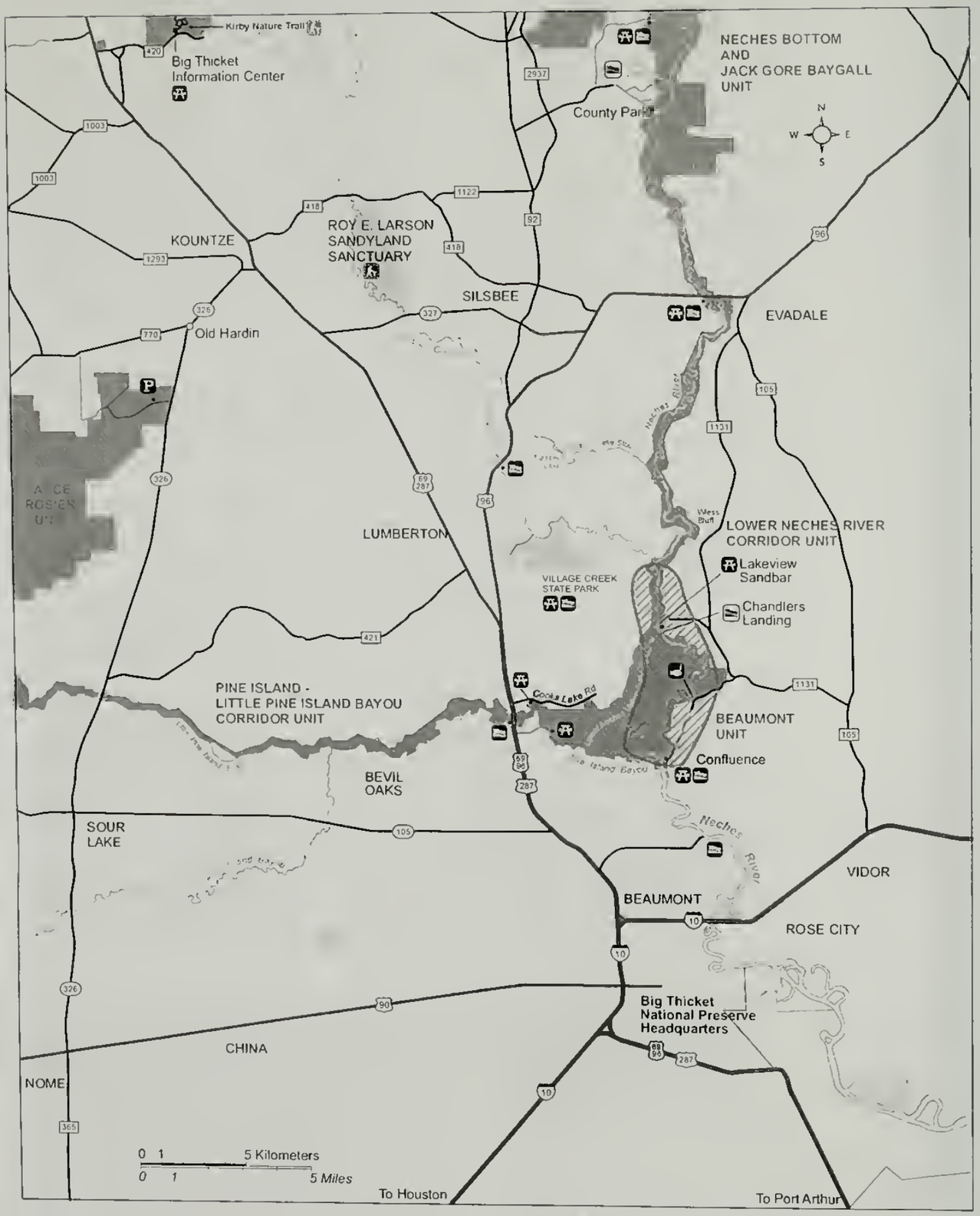
Texas

PWC Use Area









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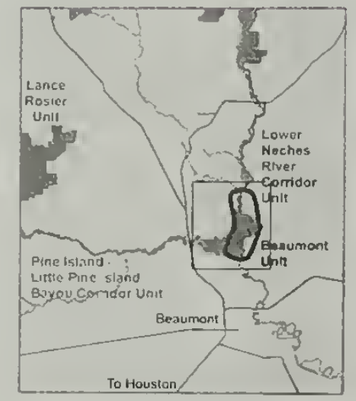
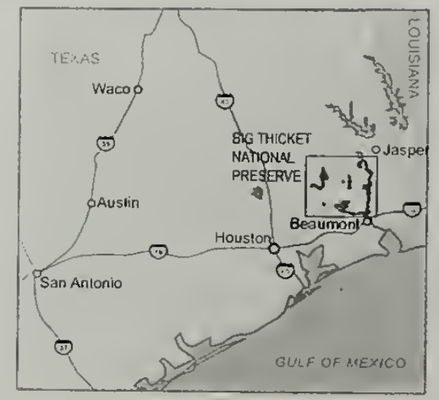
- Big Thicket National Preserve
- PWC use area
- Public area and parking
- Public boat launch
- Private boat launch
- River access (no boat launching)

Big Thicket National Preserve

Texas

PWC Use Area





BACKGROUND

NPS Organic Act and Management Policies

By enacting the National Park Service Organic Act of 1916 (Organic Act), Congress directed the U.S. Department of the Interior and the National Park Service to manage units "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that the National Park Service must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 USC 1a-1).

Despite these mandates, the Organic Act and its amendments afford the National Park Service latitude when making resource decisions that balance visitor recreation and resource preservation. By these acts Congress "empowered [the National Park Service] with the authority to determine what uses of park resources are proper and what proportion of the parks resources are available for each use" (*Bicycle Trails Council of Marin v. Babbitt*, 82 F.3d 1445, 1453 (9th Cir. 1996)).

Yet, courts consistently interpreted the Organic Act and its amendments to elevate resource conservation above visitor recreation. *Michigan United Conservation Clubs v. Lujan*, 949 F.2d 202, 206 (6th Cir. 1991) states, "Congress placed specific emphasis on conservation." The *National Rifle Ass'n of America v. Potter*, 628 F. Supp. 903, 909 (D.D.C. 1986) states, "In the Organic Act Congress speaks of but a single purpose, namely, conservation." The NPS *Management Policies* also recognize that resource conservation takes precedence over visitor recreation. The policy dictates "when there is a conflict between conserving resources and values and providing for enjoyment of them, conservation is to be predominant" (NPS *Management Policies 2001*, sec. 1.4.3).

Because conservation remains predominant, the National Park Service seeks to avoid or to minimize adverse impacts on park resources and values. Yet, the Park Service has discretion to allow negative impacts when necessary (NPS *Management Policies 2001*, sec. 1.4.3). While some actions and activities cause impacts, the National Park Service cannot allow an adverse impact that constitutes a resource impairment (NPS *Management Policies*, sec. 1.4.3). The Organic Act prohibits actions that permanently impair park resources unless a law directly and specifically allows for the actions (16 USC 1a-1). An action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS *Management Policies*, sec. 1.4.4). To determine impairment, the National Park Service must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (NPS *Management Policies*, sec. 1.4.4).

Because park units vary based on their enabling legislation, natural resources, cultural resources, and missions, the recreational activities appropriate for each unit and for areas within each unit vary as well. An action appropriate in one unit could impair resources in another unit. Thus, this environmental assessment analyzes the context, duration, and intensity of impacts related to PWC use at Big Thicket National Preserve, as well as potential for resource impairment, as required by *Director's Order #12: Conservation Planning, Environmental Impact Analysis and Decision-making (DO-12).*

SUMMARY OF RESEARCH ON THE EFFECTS OF PERSONAL WATERCRAFT

Over the past two decades PWC use in the United States has increased dramatically. However, there are conflicting data about whether PWC use is continuing to increase. The National Transportation Safety Board (NTSB) estimates that retailers sell approximately 200,000 personal watercraft each year, and that people currently use another 1 million (NTSB 1998). However, the PWC industry argues that PWC sales have decreased by 50% from 1995 to 2000 (American Watercraft Association [AWA] 2001).

Environmental groups, PWC users and manufacturers, and land managers express differing opinions about the environmental consequences of PWC use, and about the need to manage or to limit this recreational activity. Research conducted on the effects of PWC use is summarized below for water pollution, air pollution, noise, wildlife, vegetation and shoreline erosion, and health and safety.

Water Pollution

The vast majority of PWC in use today are two-stroke, non-fuel-injected engines, which discharge as much as 25% of their gas and oil emissions directly into the water (NPS 1998). Hydrocarbons, benzene, toluene, and xylene are also released, as well as methyl tertiary-butyl ether (MTBE) in states that use this additive. In 1996, the Environmental Protection Agency promulgated a rule to control exhaust emissions from new marine engines, including outboards and personal watercraft. Emission controls provide for increasingly stricter standards beginning in model year 1998 (US EPA 1996a). As a result of the rule, the agency expects a 50% reduction in hydrocarbon emissions from marine engines from present levels by 2020 and a 75% reduction in hydrocarbon emissions by 2025 (US EPA 1996a).

The amount of pollution correctly attributed to personal watercraft compared to other motorboats and the degree to which personal watercraft affect water quality remains debatable. As noted in a report by the Oregon Department of Environmental Quality, every waterbody has different conditions (e.g., water temperature, air temperature, water mixing, motorboating use, and winds) that affect the pollutants' impacts (ODEQ 1999). A recent study by the California Air Resources Board (2001) showed differences in emissions among different size engines and two-stroke vs. four-stroke technology for both outboard and PWC engines.

Discharges of MTBE and polyaromatic hydrocarbons (PAH) particularly concern scientists because of their potential to adversely affect the health of people and aquatic organisms. Scientists need to conduct additional studies on PAHs (Allen et al. 1998) and on MTBE (NPS 1999), as well as long-term studies on the effect of repeated exposure to low levels of these pollutants (Asplund 2001).

Air Pollution

Two-stroke engines that have been conventionally used in personal watercraft emit pollutants such as nitrogen oxides (NO_x) and volatile organic compounds (VOCs) that may adversely affect air quality. In areas with high PWC use some air quality degradation likely occurs. Kado et al. (2000) found that two-stroke engines had considerably higher emissions of airborne particulates and PAHs than four-stroke engines tested. It is assumed that the 1996 EPA rule concerning marine engines will substantially reduce air emissions from personal watercraft in the future (US EPA 1996a).

Noise

Noise levels emitted by PWC engines vary from vessel to vessel, depending on many factors. There is no definitive literature describing scientific measurements of PWC noise. Some PWC industry literature states that all recently manufactured watercraft emit fewer than 80 decibels (dB) at 50 feet from the vessel, whereas some literature from public interest groups attribute levels as high as 102 dB without specifying distance. None of this literature adequately describes the methodology for collecting the data to determine those levels. Because of this, the National Park Service contracted noise measurements of personal watercraft and other boat types in 2001 at Glen Canyon National Recreation Area; preliminary analysis of this data indicates maximum levels for PWC-generated noise at 50 feet of approximately 68 to 78 A-weighted dB (dBA). Other motorboat types were measured during that study at approximately 65 to 86 dBA at 50 feet. Regulations for boating and water use activities established by the National Park Service prohibit vessels from operating at more than 82 dB measured at 82 feet from the vessel (36 CFR 3.7). However, this regulation does not imply that there are no noise impacts from vessels operating below that limit. Noise impacts from PWC use are caused by a number of factors. Noise complaints against PWC use seem to focus as much or more on frequent changes in pitch and sound energy levels due to rapid acceleration, deceleration, jumping into the air, and change of direction, as on noise levels themselves. Noise from human sources, including personal watercraft, can intrude on natural soundscapes, masking the natural sounds which are an intrinsic part of the environment. This can be especially true in quiet places, such as in secluded lakes, coves, river corridors, and backwater areas. Also, PWC use in areas where there are nonmotorized users (such as canoeists, sailors, people fishing or picnicking, and kayakers) will continue to cause user conflicts.

PWC users tend to operate close to shore, to operate in confined areas, and to travel in groups, making noise more noticeable to other recreationists (e.g., if identical boats emit 75 dB, two such boats together would emit 76 dB, three together 77 dB, etc.). Motorboats traveling back and forth in one area at open throttle or spinning around in small inlets also generate complaints about noise levels; however, most motorboats tend to operate away from shore and to navigate in a straight line, thus being less noticeable to other recreationists (Vlasich 1998).

Wildlife Impacts

Although relatively few studies have specifically examined PWC effects on wildlife, several researchers have documented wildlife disturbances from personal watercraft and motorboats. A study recently completed in Florida examined the distance at which waterbirds are disturbed by both personal watercraft and outboard-powered boats (Rodgers and Schwikert 2002). Flush distances varied from 65 to 160 feet for personal watercraft, and flush distances for most species were greater for motorboats than for personal watercraft 80% of the time. The authors note that PWC use may be more threatening to waterbirds since they can navigate in shallow secluded waterways where birds typically eat and rest.

Shoreline Vegetation

The effects of personal watercraft on aquatic communities have not been fully studied, and scientists disagree about whether personal watercraft adversely impact aquatic vegetation. The majority of concern arises from the shallow draft of personal watercraft, allowing them access to shallow areas that conventional motorboats cannot reach. Like other vessels, personal watercraft may destroy grasses that occur in shallow water ecosystems.

Erosion Effects

Some studies have examined the erosion effects of PWC-generated waves and other studies suggest that personal watercraft may disturb sediments on river or lake bottoms and cause turbidity. Conflicting research exists concerning whether PWC-generated waves result in erosion and sedimentation. PWC wave sizes vary depending on the environment, including weight of the driver, number of passengers, and speed.

Health and Safety Concerns

While PWC industry representatives report that PWC accidents decreased in some states in the late 1990s, no other research supports their contention. To the contrary two national studies of PWC accidents and injuries report that personal watercraft pose a clear health and safety risk, primarily to the operators. In the 1990s PWC accidents increased as the popularity of the activity increased. The National Transportation Safety Board reported that in 1996 personal watercraft represented 7.5% of state-registered recreational boats but accounted for 36% of recreational boating accidents. In the same year PWC operators accounted for more than 41% of people injured in boating accidents. PWC operators accounted for approximately 85% of the persons injured in accidents studied in 1997 (NTSB 1998). Some manufacturing changes on throttle and steering may reduce potential accidents. For example, on more recent models, Sea-Doo developed an off-power assisted steering system that assists steering during off-power as well as off-throttle situations. This system is, according to company literature, designed to provide additional maneuverability and improve rate of deceleration (Sea-Doo 2001a).

PWC Use and Regulation at Big Thicket National Preserve

Most water-dominated units at Big Thicket National Preserve are not conducive to watercraft use because they are inaccessible or lack established boat ramps. Seasonal waterflows, submerged obstructions, and temporary saltwater barriers occasionally restrict navigability of the Neches River. In addition, the characteristics of waterbodies within Big Thicket (alluvial river, bayous, sloughs, swamps, and small backwater streams) dictate the types of water activities and watercraft accessibility.

PWC use at Big Thicket most frequently occurs in the Neches River corridor near established campsites, picnic grounds, docks/houses, or exposed sandbars (particularly the Lakeview sandbar). PWC users often come in groups, with only a limited number of personal watercraft, and they prefer to stay near the rest of the group located on the shore. Similar to other types of watercraft use, PWC use most frequently occurs during the warmer months.

Although personal watercraft are more maneuverable and can access more areas than other types of motorized watercraft, they generally stay within more localized areas. This is due in part to the function of personal watercraft, which are primarily intended to be short-distance, recreational vehicles that can accelerate and decelerate quickly. Therefore PWC users at Big Thicket commonly use somewhat open waters where they can go fast and perform stunts; they sometimes explore narrower waterways, but they are not often found, for example, weaving between trees.

The 1999 Superintendent's Compendium limits PWC use to the Neches River downstream from the confluence with Village Creek (referred to the as the lower Neches River in this document) and in the Pine Island Bayou downstream from the mouth of Cook's Lake (see the map for Alternative A for this location, page 23). The compendium is reprinted in appendix A.

OBJECTIVES IN TAKING ACTION

Objectives are what must be achieved for an action to be considered a success. All alternatives selected for detailed analysis must meet all the objectives to a large degree, as well as the purpose of and need for action.

Using the national preserve's enabling legislation, mandates and direction in the *Strategic Plan*, and other management documents, the following management objectives have been identified for PWC use at Big Thicket. These are compatible with the purpose and significance statements of the national preserve.

Water Quality

- Manage PWC emissions that enter the water in accordance with anti-degradation policies and goals.
- Protect aquatic life from PWC emissions so that species are conserved.

Air Quality

- Manage PWC activity so that air pollutant emissions of harmful compounds do not appreciably degrade ambient air quality.

Soundscapes (Noise)

- Manage PWC use so that the park's natural soundscapes are affected by PWC noise only infrequently in a minority of park acreage, and so that PWC noise emissions are mostly confined to areas experiencing noise from other nonnatural sources.

Wildlife and Wildlife Habitat

- Protect fish and wildlife and their habitats from PWC disturbances.
- Protect wildlife from the effects of PWC noise.
- Protect fish and wildlife from the adverse effects that result from the bioaccumulation of contaminants emitted from personal watercraft.

Threatened, Endangered, or Special Concern Species

- Protect listed species and other species of special concern from PWC disturbances or contaminants.

Shorelines and Shoreline Vegetation

- Protect shoreline vegetation and the shoreline itself from the effects of wakes and physical disturbance from personal watercraft.

Visitor Experience

- Provide park visitors with a high-quality experience.

- Minimize potential conflicts between PWC use and park visitors.

VISITOR CONFLICTS AND SAFETY

- Minimize or reduce the potential for PWC user accidents, and the potential safety conflicts between PWC users and other water recreationists.

CULTURAL RESOURCES

- Protect important cultural resources from direct and indirect effects related to PWC use.

SOCIOECONOMIC ENVIRONMENT

- Minimize adverse impacts to the local economy.

NATIONAL PRESERVE MANAGEMENT AND OPERATIONS

- Minimize impacts to preserve operations from increased enforcement needs.
- Seek cooperation with state entities that regulate PWC use.

ISSUES AND IMPACT TOPICS

Issues associated with PWC use at Big Thicket were identified during scoping meetings with NPS staff at Big Thicket and as a result of public comments. Many of these issues were identified in the settlement agreement with the Bluewater Network, which requires that at a minimum the effects of PWC use be analyzed for the following: water quality, air quality, soundscapes, wildlife and wildlife habitat, shoreline vegetation, visitor conflicts and visitor safety. Potential impacts to other resources were considered as well. The following impact topics are discussed in the "Affected Environment" chapter and analyzed in the "Environmental Consequences" chapter. If no impacts are expected, based on available information, then the issue was eliminated from further discussion, as discussed on page 17.

WATER QUALITY

PWC use at Big Thicket could result in the release of hydrocarbons (e.g., benzene, toluene, ethyl-benzene, and xylene) and PAHs. These discharges have potential adverse effects on water quality.

At Big Thicket, while most overall water quality standards are being met, certain areas may be more sensitive to the potential effects of phototoxicity, due to their shallow depths, limited water circulation, and the potential presence of more vulnerable aquatic life. PAHs released from personal watercraft in Big Thicket may be more toxic in the presence of sunlight, which may harm aquatic life (NPS 1999). In the Neches River corridor, paddlefish (a state endangered species) feed on plankton, which are susceptible to phototoxicity.

Other water quality issues may include impacts on drinking water sources, indirect effects on threatened or endangered species sensitive to water quality changes and degradation, and effects on other fish. At Big Thicket two other issues relating to water quality are of concern: (1) PAHs released from personal watercraft may adsorb onto Neches River sediments and bioaccumulate in aquatic

organisms, and (2) pollutants released from personal watercraft in the Neches River may contaminate the local drinking and agricultural water supplies. (The potential effects on wildlife from bioaccumulation of contaminants are addressed under sections on wildlife.)

The sediment issue is of concern because the Neches River is an ecological preserve with biota that are dependent on sediment-based food chains. The Neches River also is a local drinking water supply and is used for irrigation.

Air Quality

Pollutant emissions, particularly nitrogen oxides and volatile organic compounds from personal watercraft, may adversely affect air quality. These compounds react with sunlight to form ozone. Portions of Big Thicket (Hardin, Jefferson, and Orange Counties) are located in a non-attainment area for ozone.

Soundscapes

All motorized watercraft, including personal watercraft, produce noise that may impact park soundscapes and visitor experiences. Any watercraft that does not meet the NPS watercraft noise regulation of 82 dB at 82 feet at full acceleration is subject to fine and removal from the park. Therefore, it is assumed for this analysis that 82 dB at 82 feet is the maximum that would be emitted for any legal watercraft at full acceleration (normally the "loudest" portion of its operation).

In addition, the noise from personal watercraft may be more noticeable and therefore more impacting to people than other motorcraft due to frequent changes in acceleration and direction, and jumping into the air, causing rapid increases in the noise level and changes in sound frequency distribution.

Noise impacts from PWC is an issue for some visitors at Big Thicket, especially those who enjoy fishing in the early morning hours.

Wildlife and Wildlife Habitat

Personal watercraft may interrupt wildlife activities, causing alarm or flight, avoidance of habitat, and effects on reproductive success. Noise from personal watercraft may displace or disrupt waterfowl, nesting birds, or other wildlife along the Neches River and its tributaries.

Threatened, Endangered, and Special Concern Species

Personal watercraft may harm threatened or endangered species and/or their habitat. Direct mortality to paddlefish may occur from collision. PWC emissions may also harm paddlefish because of degraded water quality or bioaccumulation of contaminants. Noise from personal watercraft may also disrupt wood stork activities.

SHORELINES AND SHORELINE VEGETATION

Personal watercraft are able to access areas where most other motorcraft cannot go, which may disturb sensitive plant species. In addition, personal watercraft may land on the shoreline, allowing visitors access to areas where sensitive plant species exist. Wakes created by personal watercraft may affect shorelines and cause erosion.

VISITOR EXPERIENCE

Personal watercraft are viewed by some segments of the public as a nuisance due to their noise, safety hazards, operational style, and overall environmental effects. Other visitors believe that personal watercraft are no different from other motorcraft and that PWC operators have a right to enjoy their selected recreational activity.

VISITOR CONFLICTS AND SAFETY

While there have been no reported PWC accidents in Big Thicket, PWC speeds, wakes, and proximity to other users can pose conflicts and safety hazards. Collisions may result with nonmotorized boaters (canoeists, kayakers, etc.) or persons in the river (waders, swimmers, and submerged water recreationists), due to the limited line of sight in the Neches River and its tributaries.

CULTURAL RESOURCES

Some units may have cultural resources listed on, or potentially eligible for listing on, the National Register of Historic Places. These sites may be affected if they are along shorelines (by erosion), or by uncontrolled visitor access since riders are able to access/beach/launch at areas less accessible to most motorcraft.

SOCIOECONOMIC ENVIRONMENT

PWC sales are one of the fastest growing segments of the boating industry in the country. Nationally, PWC rentals have also increased exponentially compared to other types of motorcraft. At Big Thicket there is less PWC use in the area of the preserve. However, some businesses may be affected by actions to either increase or decrease PWC use.

NATIONAL PRESERVE MANAGEMENT AND OPERATIONS

Conflict with State and Local Ordinances and Policies Regarding PWC Use

Some states and local governments have taken action, or are considering taking action, to limit, ban, and otherwise manage PWC use. While a national park system unit may be exempt from these local actions, consistency with state and local plans must be evaluated in accordance with the National Environmental Policy Act.

Impact to Preserve Operations from Increased Enforcement Needs

No PWC accidents have been reported at Big Thicket; however, if PWC use increases, additional park staff will be required to enforce standards and limits.

ISSUES ELIMINATED FROM FURTHER CONSIDERATION

All the mandatory topics identified in section 4.5 of the NPS *Director's Order #12 Handbook* (NPS 2001b) are analyzed in this environmental assessment except the topics listed below. These topics have been dismissed because the range of PWC alternatives would have no effect on these resources or because the impacts have been evaluated within another impact topic.

Wetlands — Any potential impacts to wetlands in the vicinity of the shoreline are evaluated under the topic "Shorelines and Shoreline Vegetation." (The extent of the area of impact is defined in the methodology section for shoreline vegetation.) Wetlands that occur farther inland within the preserve would not be affected by PWC use because of the limited distance that PWC users generally walk when not using their machines.

Floodplains — The level of PWC use and associated PWC activities identified in each alternative would have no adverse impacts on floodplains. No development is proposed in the alternatives; thus, no flooding would result as a result of PWC use and cause impacts to human safety, health or welfare.

Prime and Unique Agricultural Lands — No prime and unique agricultural farmland exists in the vicinity of areas that would be affected by PWC use.

Energy Requirements and Natural or Depletable Resource Requirements — PWC operation requires the use of fossil fuels. While PWC use could be limited or banned within Big Thicket National Preserve, no alternative considered in this environmental assessment would affect the number of personal watercraft used within the region or the amount of fuel that is consumed. The level of PWC use considered in this environmental assessment is minimal. Fuel is not now in short supply, and PWC use would not have an adverse effect on continued fuel availability .

Impacts to Economically Disadvantaged or Minority Populations (Executive Order 12898) — This was dismissed as an impact topic for the following reasons: there are few PWC rentals in the Beaumont area, PWC use and sales cross all income levels and races, and personal watercraft are not used exclusively near low-income or minority communities. A number of visitors who fish or hunt in the national preserve consume the fish or wildlife they catch; however, this is not the primary source of food for the majority of (potentially low-income) hunters or fishermen. There are also some potentially low-income and/or minority residences along the Neches River, but personal watercraft are not used exclusively near these residences, and some of these residents own personal watercraft themselves.

Sacred Sites/Native American Concerns — This issue was dismissed because there are no known Native American traditional cultural properties along the lower Neches River and its tributaries, and floodplains are very low probability areas for such resources.

RELATIONSHIP TO OTHER PLANS, POLICIES, AND ACTIONS

BIG THICKET PLANS, POLICIES, AND ACTIONS

Several plans, policies, or actions that Big Thicket National Preserve either has in place or in progress may affect decisions for PWC use. Existing plans and policy documents that discuss use of the Neches River and/or the preserve's resource quality and visitor use characteristics include the *Master Plan*, the *Strategic Plan*, the *Water Corridors Management Assessment*, the *Resources Management Plan*, and the *Visitor Use/General Development Plan*. These documents have been used during the PWC planning effort to ensure consistency with existing plans and policies.

Big Thicket is currently developing a general management plan to replace its current *General Management Plan*. The new management plan will treat the Neches River as a planning unit, with different allowable uses in different areas, similar to the current spatial limitations on PWC use imposed by the "Superintendent's Compendium." Also, the plan will likely propose ways to provide better access to the river, including more boat ramps, and will probably include limitations on certain motorized watercraft use in certain areas, similar to the alternatives considered in this environmental assessment. Public comments from the 10 public workshops held in and around Big Thicket, along with comments on postcards recently received regarding limiting PWC use will be incorporated in the updated plan. Commenters both supported and denounced PWC use. The park intends to coordinate the GMP planning process with the PWC rulemaking effort as much as possible for consistency purposes.

Big Thicket is also currently developing a *Draft Oil and Gas Management Plan / Environmental Impact Statement* to assist with the management of existing and anticipated oil and gas operations associated with nonfederal and transpark oil and gas interests underlying Big Thicket. No other major plans, policies, or actions currently being developed by Big Thicket were identified at the scoping meetings for this project.

OTHER PLANS, POLICIES, AND ACTIONS

Several non-NPS actions or plans were identified by the Big Thicket staff during the scoping meetings that could be related to PWC use and were evaluated for the cumulative impact analysis. These actions include both existing and proposed plans:

- The Army Corps of Engineers is constructing a new permanent saltwater barrier and associated boat launch on the Neches River about 0.5 mile south of the national preserve boundary south of Confluence. The project is being undertaken in association with the city of Beaumont and the Lower Neches Valley Authority (LNVA). Implementation of these facilities may increase PWC use on the river and in the preserve, due to the increased access at the launch site.
- Construction of a new dam (Dam A) is being planned conceptually upstream from Steinhagen Dam to provide additional water supply. This dam has been included as part of several area water plans, but there is no firm date yet for construction, and federal funding has not been secured to date. If and when it is constructed, the dam may affect PWC use on the river and in the preserve, possibly bringing more people to the area or possibly diverting PWC use away from the river corridor to the new reservoir.
- Changes in seasonal water release from upstream reservoirs are anticipated due to the potential construction and implementation of the saltwater barrier and Dam A. These facilities are likely to decrease the medium daily downstream flow, resulting in a reduced amount of navigable

water for PWC use. This in turn may drive PWC users elsewhere and potentially increase the use of personal watercraft in the national preserve.

- Jasper County has indicated the desire to construct a boat ramp between the Neches Bottom / Jack Gore Baygall Unit and Route 1013 at the northern end of the Neches River. This is currently an informal proposal, and actual construction of the boat ramp will depend on the completion of the Neches River plan. If construction of this boat ramp does occur, it will likely increase boat use in the area immediately surrounding the ramp, although PWC use is prohibited in this area. However, unauthorized PWC use on the Neches River may occur or increase as a result.
- Currently, point-source pollution (permitted releases) occurs at the pulp mill in Evadale, the plywood mill at Silsbee, and municipal wastewater treatment plants in Lumberton, Silsbee, and Woodville. These releases may affect water quality in the project area.
- Population increases resulting in urbanization and development along the entire Neches River corridor may result in more non-point runoff. Increased urbanization is also likely to lead to greater sewage production, resulting in the construction of more septic tanks and possibly treatment plants.
- Lumber companies that work near Big Thicket often practice clear-cutting of large portions of the watershed, leaving narrow buffers that allow runoff to more quickly reach the river. Many of these companies also use herbicides (instead of controlled fires) to reduce potential fire hazards, and they do not regularly implement best management practices to manage and protect resources.
- There is little agriculture in the immediate area; however, ranching activities in the surrounding area produce non-point pollution, which may affect downstream water quality.
- Exploration and development of oil and gas operations in the general area may impact land and water resources from spills of oil, chemicals, and produced water.
- Refineries and a motor oil reclamation facility are located mainly south of the national preserve and likely contribute to air pollution in the surrounding area.
- Various industries and municipalities use water, particularly from the LNVA canal. For example, agricultural fields, including rice and soybean fields west of Beaumont (some of which are changing to sugar cane) use water from the LNVA canal.
- There is the potential for construction of a new natural gas power plant in the general area due to recent power shortages. Such a project could have potential adverse impacts because of the amount of water needed.

ALTERNATIVES

All alternatives must be consistent with the purpose and significance of Big Thicket National Preserve, and they must meet the purpose of and need for action, as well as the objectives for the project.

Table 1 at the end of this chapter summarizes the alternatives being considered. Table 2 summarizes the impacts of each alternative.

ALTERNATIVE A — CONTINUE PWC USE AS CURRENTLY MANAGED UNDER A SPECIAL REGULATION

PWC use would continue in all areas where it is currently allowed, as defined in the "Superintendent's Compendium." Under this alternative, the following use areas would be defined in a special regulation:

- PWC use would be permitted within the main channels (including all connected oxbows or other backwater areas) of the Neches River and Pine Island Bayou, north to the confluence of the Neches River with Village Creek, and west to the mouth of Cook's Lake (as per the attached section of the Superintendent's Compendium (appendix A and the map of Alternative A).

- All state and federal watercraft laws and regulations would be enforced, including all state regulations, which prohibit the following:

  reckless or negligent operation

  excessive speed for conditions

  hazardous wake or wash

  jumping the wake of another vessel recklessly or too close to the vessel

  operation in a manner that requires last-minute swerves to avoid accidents

  operation between sunset and sunrise

  operation within 50 feet of any other person, vessel, stationary platform, or other object

  operation by a person under 16 years of age, unless the person is at least 13, and has either completed an approved boating safety course or is accompanied by a person 18 years or older.

  State regulations also require a personal floatation device for each person on board and a cutoff switch on the engine.

Craft could land on any shoreline in the area, although because Big Thicket's thick floodplain forests form a natural shoreline barrier, PWC users generally do not land anywhere but on sandbars and visitor use/launch areas. There would be no limits on the numbers of craft. Any type of engine would be allowed.

All of the restrictions contained in the current Superintendent's Compendium would be in the special regulation and would remain in effect for both the short and long term, including all of the state regulatory requirements.

ALTERNATIVE B — CONTINUE PWC USE UNDER A SPECIAL REGULATION, BUT IMPLEMENT ADDITIONAL RESTRICTIONS AND EDUCATE VISITORS

This alternative would restrict PWC use to the central channels of the Neches River and Pine Island Bayou, with the same upstream limits as already contained in the Superintendent's Compendium (north to Village Creek and west to the mouth of Cook's Lake). PWC use in all connected oxbows and other backwater areas along the central river channels would be prohibited (see the map for Alternative B).

Under this alternative the following management strategies would also be adopted:

- Timing Restriction: PWC use in approved areas would be limited to the period from three hours after sunrise to one hour before sunset in order to reduce conflicts with anglers, who generally use the river during the early morning hours, and to accommodate the main hours for PWC use on the river.
- Engine-Type Restriction: All personal watercraft would have to have four-stroke engines. (This would be phased in at a certain date in the future).
- Increased User Education: The National Park Service would attempt to educate PWC users about restrictions, safe operation, etc. Staff would provide such things as signs at launch sites or sensitive areas, brochures, training, and education during enforcement.

All state regulations as described for alternative A would be enforced.

Alternative B is the preserve's preferred alternative and the environmentally preferred alternative.

NO-ACTION ALTERNATIVE

For the purposes of this analysis, the no action alternative assumes a scenario of discontinuing all PWC use at this unit. At the end of the grace period (April 2002), the National Park Service would take no further action to adopt special regulations retaining PWC use, which would result in a ban on PWC use indefinitely.

THE ENVIRONMENTALLY PREFERRED ALTERNATIVE

The environmentally preferred alternative is defined by the Council on Environmental Quality as the alternative that best meets the criteria or objectives set out in section 101 of the National Environmental Policy Act. The identification of the environmentally preferred alternative is that which best meets the following requirements:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Ensure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.

- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

The environmentally preferred alternative is the alternative that causes the least damage to the biological and physical environment — the alternative that best protects, preserves, and enhances historic, cultural, and natural resources. This discussion also summarizes the extent to which each alternative meets section 102(1) of the National Environmental Policy Act, which asks that agencies administer their own plans, regulations, and laws so that they are consistent with the policies outlined above to the fullest extent possible.

Alternative A satisfies the majority of the six requirements detailed above; however, alternative A does not ensure safe, healthful, productive, and aesthetically pleasing surroundings because PWC use would be allowed in areas frequented by passive outdoor recreationists. Alternative A would not attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences because of the potential impacts of PWC use to visitor experience, wildlife, and other recreational opportunities in the park such as fishing, canoeing and observation of wildlife. For this reason, alternative A is not preferred from an environmental perspective.

Alternative B has similar impacts on park resources and visitor use and experience. However, alternative B would better meet park goals with respect to protection of water and air resources with the phasing out of non-compliant two-stroke PWC engines within preserve boundaries. Alternative B would also better meet park goals of preservation of diverse natural biological resources by allowing PWC use in the central channels of the Neches River and other areas, while restricting PWC use in more sensitive oxbows and other backwater areas. In the long term it would help visitors enjoy a beneficial use of the park, allowing for access to park amenities by PWC users while accommodating passive outdoor recreationists and meeting resource management objectives. This alternative emphasizes the recreational opportunities for visitors while protecting sensitive natural and cultural resources. Alternative B is designed to meet the National Park Service's general prohibition on PWC use for the protection of park resources and values while providing access to the park by PWC operators.

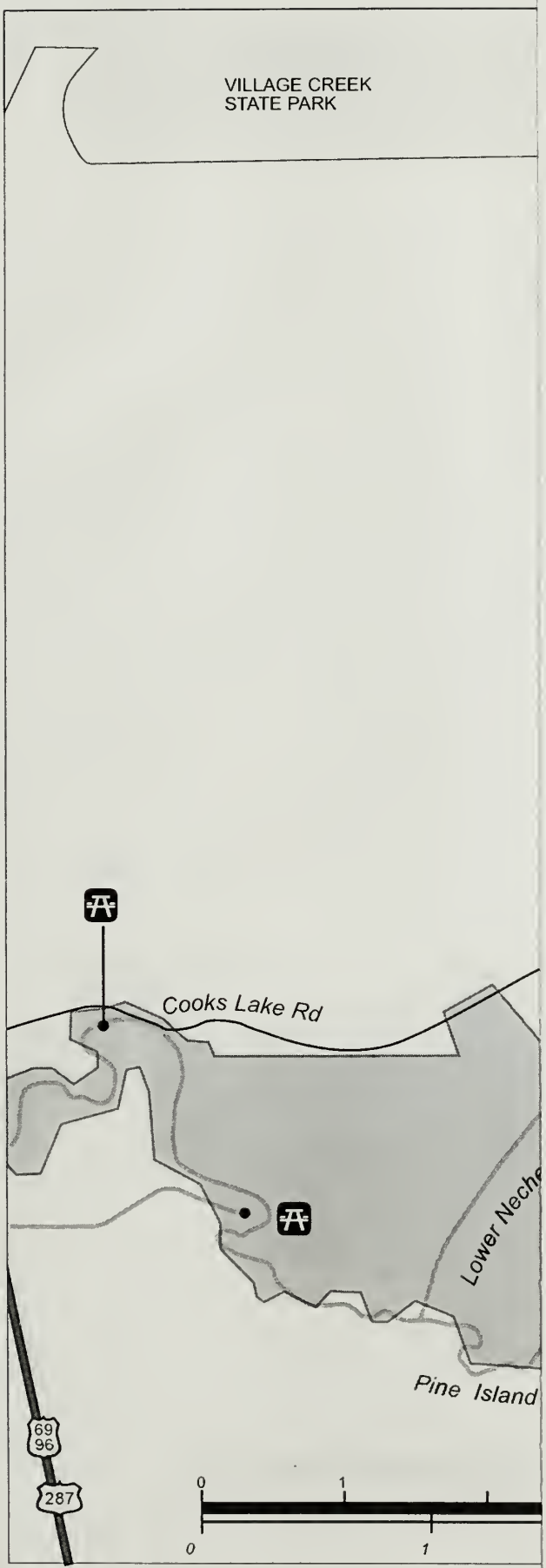
The no-action alternative would ensure a safe, healthful, productive, and aesthetically and culturally pleasing area for visitors to access without the threat of PWC users entering the area and thereby introducing noise and safety considerations. The no-action alternative attains the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences associated with removing personal watercraft from the park entirely. However, the no-action alternative would not maintain an environment that supports diversity and variety of individual choice, nor would it achieve a balance between population and resource use that permits a wide sharing of amenities.

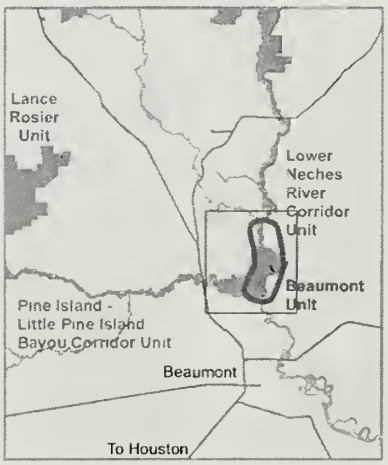
Based on the environmental analysis prepared for PWC use at Big Thicket National Preserve, alternative B is considered the environmentally preferred alternative because it would best fulfill park responsibilities as trustee of this sensitive habitat; ensure safe, healthful, productive, and aesthetically and culturally pleasing surroundings; and attain a wider range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.

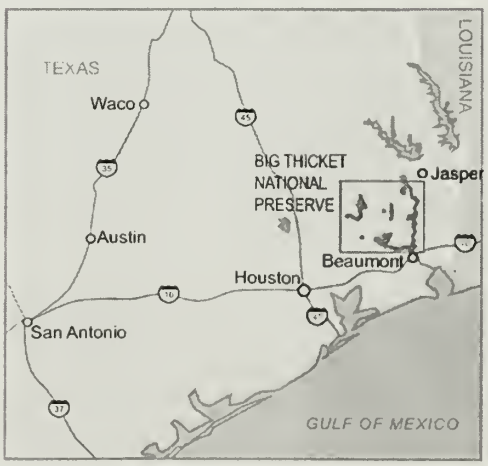
Big Thicket National Preserve

Texas

Alternative A -- Continue PWC Use under a Special Regulation



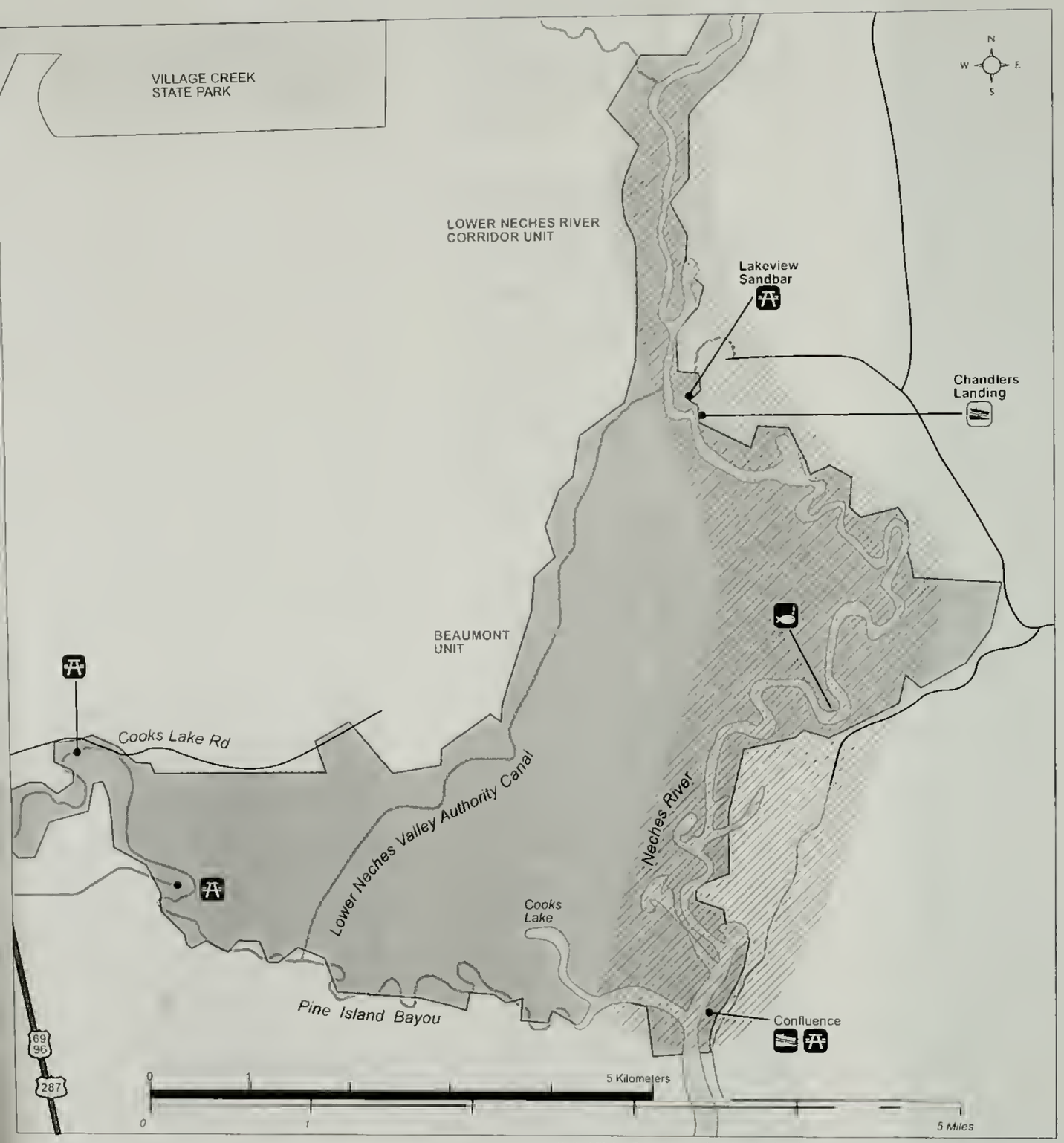




Big Thicket National Preserve

Texas

Alternative A -- Continue PWC Use under a Special Regulation



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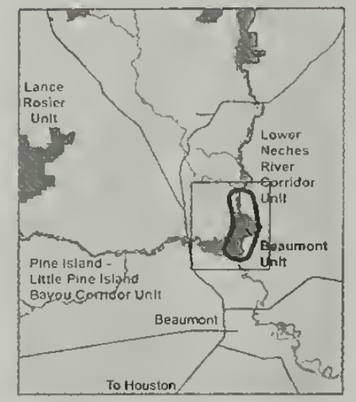
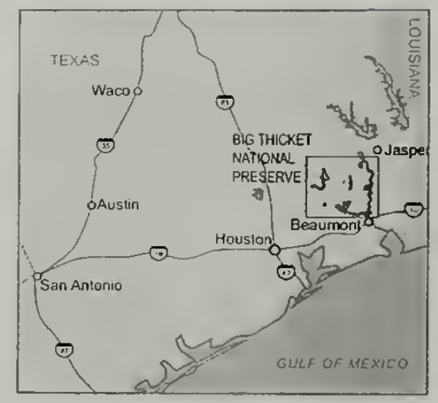
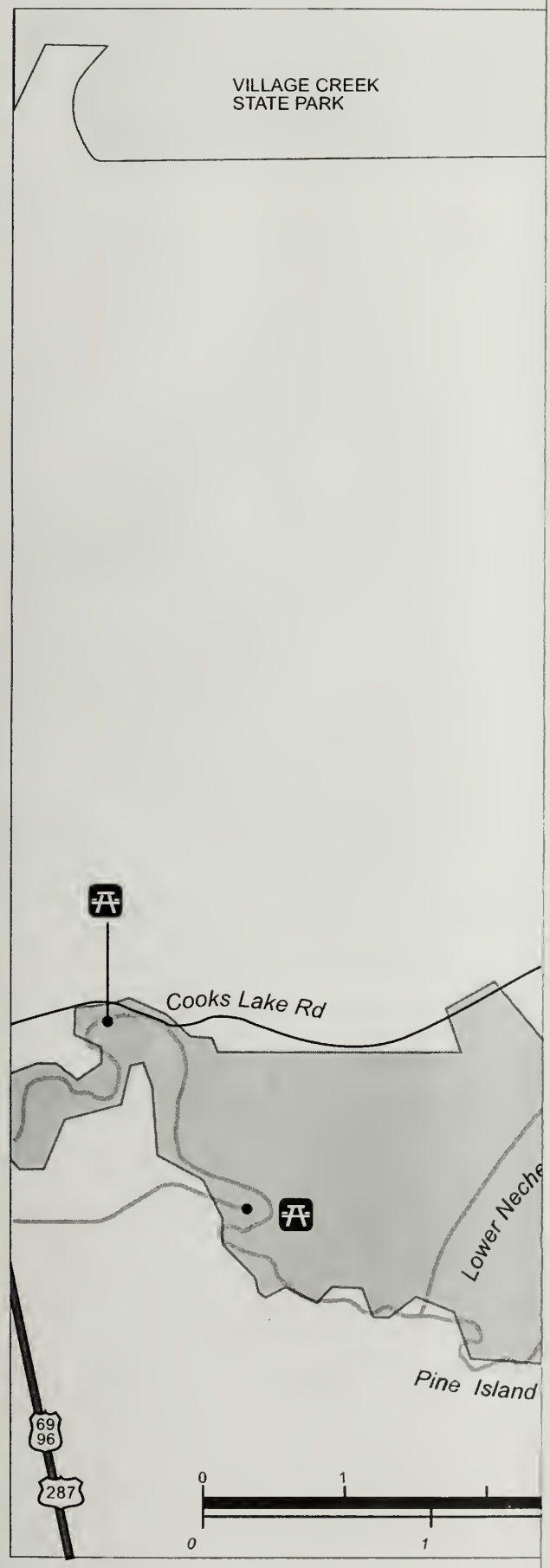


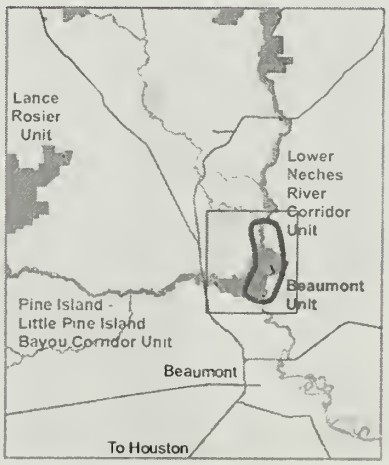


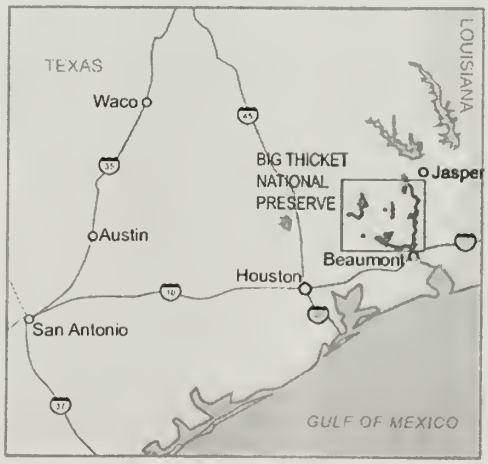
Big Thicket National Preserve

Texas

Alternative B -- Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors



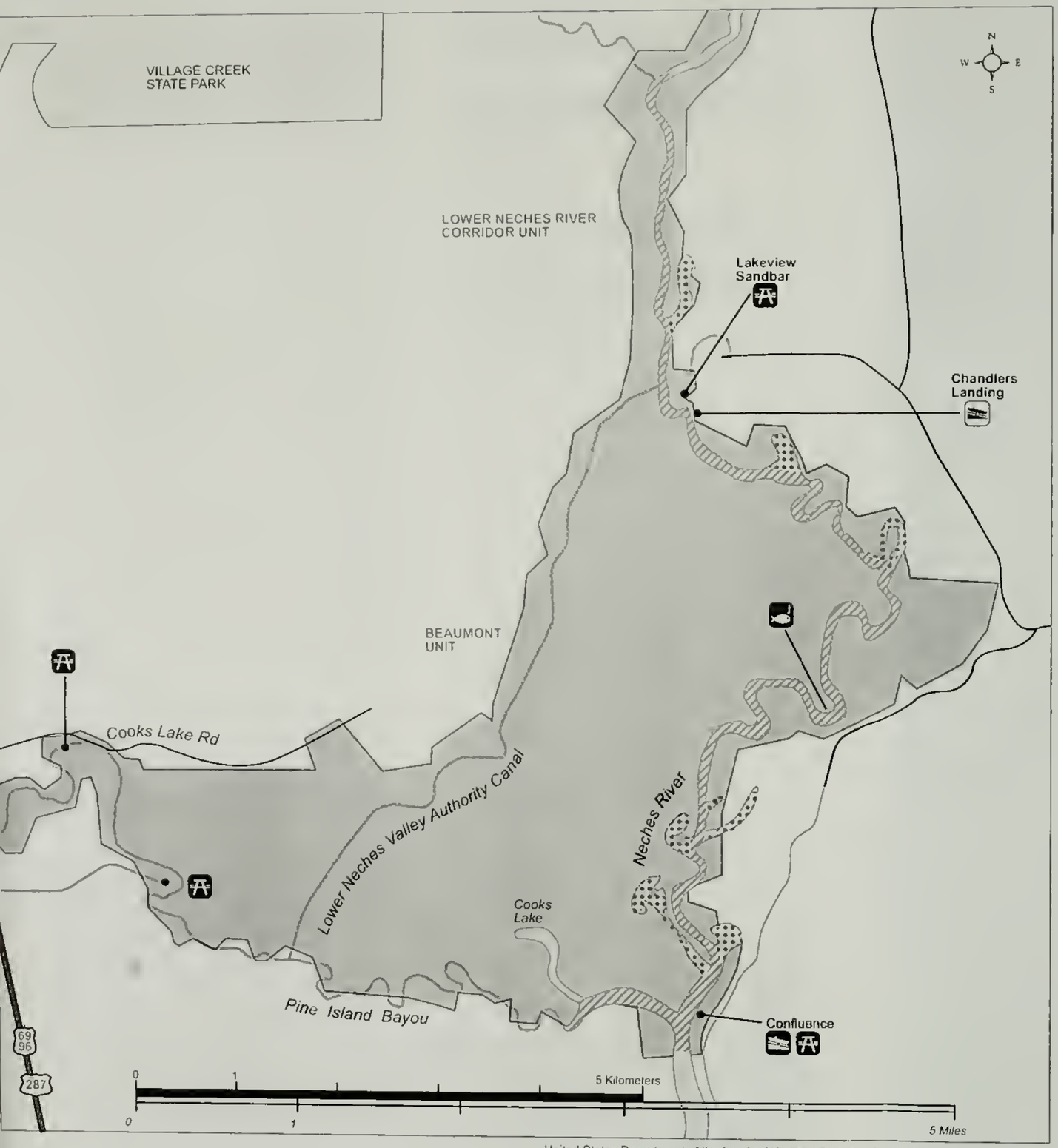


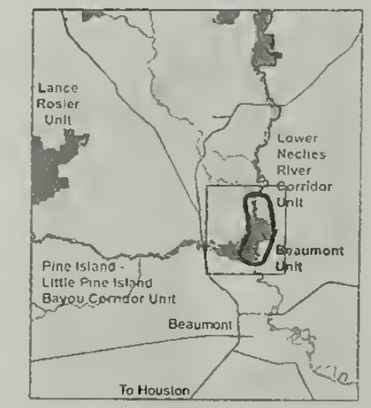


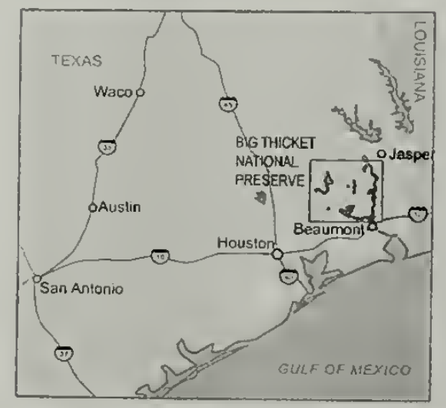
Big Thicket National Preserve

Texas

Alternative B -- Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors







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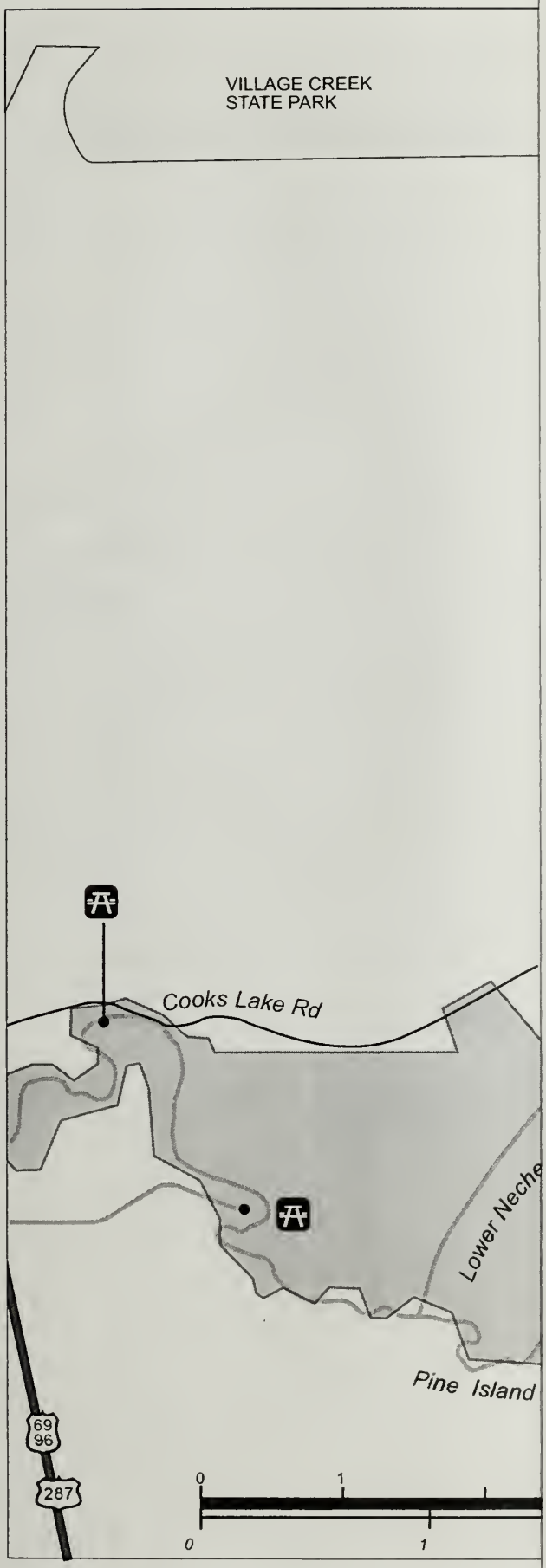
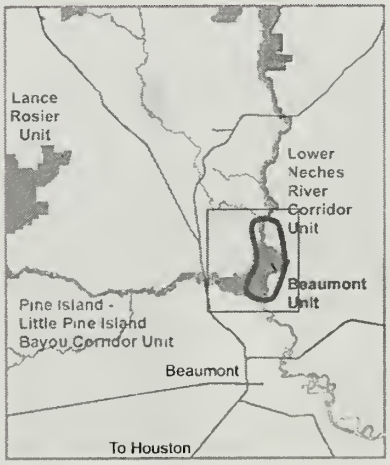
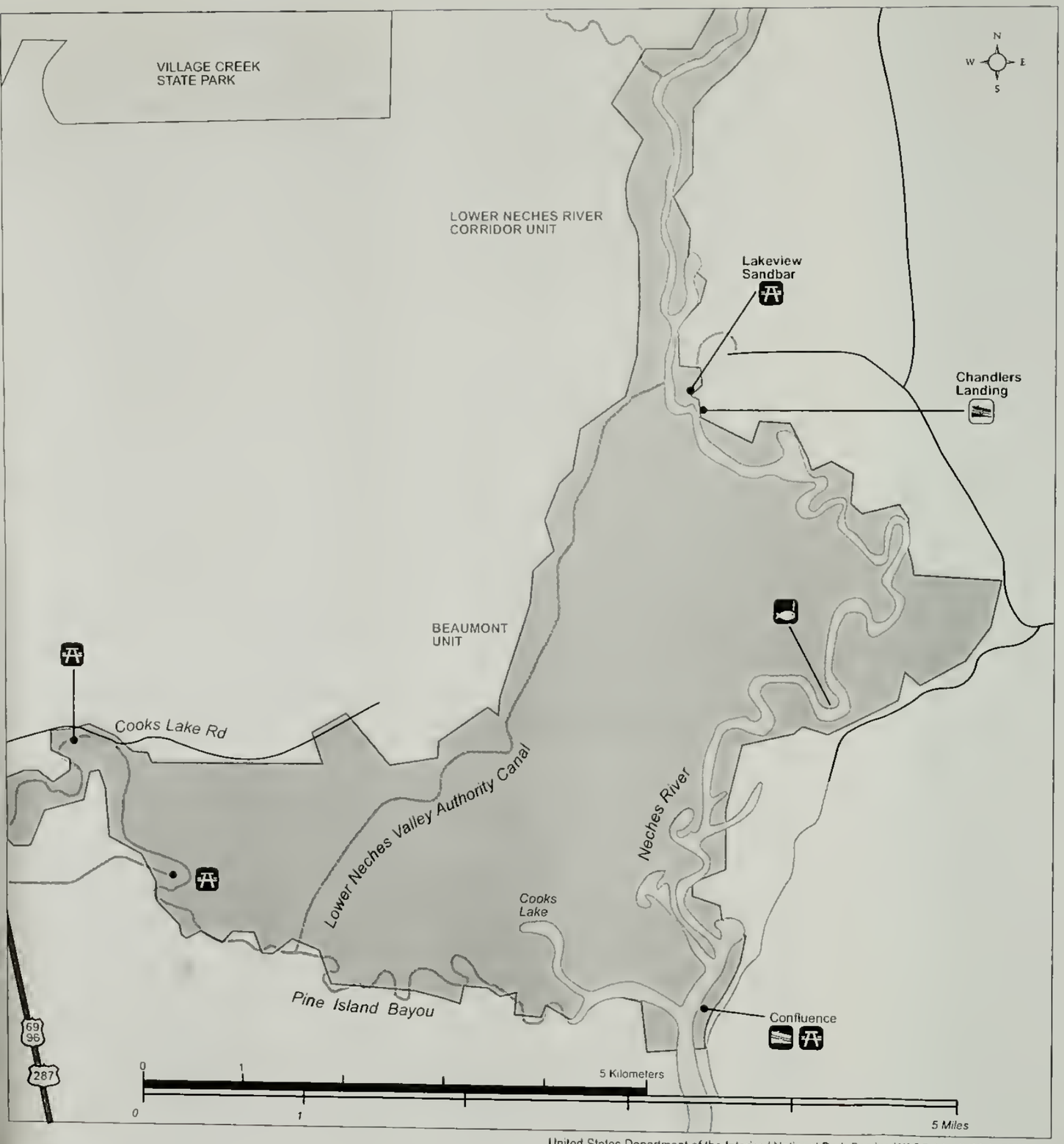
Big Thicket National Preserve

Texas

No-Action Alternative -- No PWC Use after April 2002



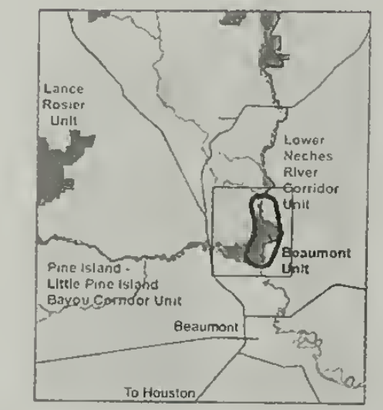




Big Thicket National Preserve

Texas

No-Action Alternative -- No PWC Use after April 2002



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ALTERNATIVES CONSIDERED BUT NOT ANALYZED FURTHER

Several management strategies or mitigation techniques were considered but eliminated as alternatives or components of alternatives for the following reasons:

1. *Restrict personal watercraft to the Neches River channel only (i.e., allow no entry to Pine Island Bayou)* — This alternative was eliminated because it would have created a "traffic jam" at the junction of the bayou and the main stem of the Neches River. PWC users often turn around in this area and head south. If restricted, PWC users would have to turn around in the main stem, possibly in the path of other boats entering the bayou, or they would continue farther north into the preserve, potentially impacting other resources, rather than keeping impacts localized in the Collier's Ferry area.

2. *Restrict landing of personal watercraft to sandbars and visitor use (launch) areas only* — This option was eliminated because it already occurs without restrictions because of natural barriers along the shoreline, such as dense vegetation, snakes, alligators, and insects.

3. *Limit PWC numbers through implementation of a permit system* — This alternative was eliminated after additional consideration of the staffing, costs, and logistics needed to successfully implement the system. An examination of park staff resources (both current numbers and what could be reasonably expected in the future) indicated that there would not be sufficient personnel to initiate and continue to implement a permit system, with appropriate tracking. There would also be insufficient staff to patrol the river to adequately implement and enforce this alternative. There are no specific checkpoints or entry points for river use where permits could be easily checked, and it is difficult to verify a PWC permit sticker from a distance, so more patrols would need to approach vessels to check on their status. Therefore, this alternative was eliminated from further analysis.

4. *Combine use of a permit system and the limitation on area of use included in alternative B* — This alternative was devised to include limits on both the area of use (as described in alternative B) and on numbers of PWC users on the river, through implementation of a permit system. Once the decision was made that a permit system would not be workable, this alternative was also eliminated from further consideration.

TABLE 1: SUMMARY OF ALTERNATIVES

	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
PWC Management	Allow PWC use under a special regulation.	Allow PWC use under a special regulation.	Discontinue PWC use.
Use Area	Permit use within the main river channels, including all connected oxbows and other backwater areas of the Neches River and Pine Island Bayou, north to Village Creek, and west to mouth of Cook's Lake.	Restrict use to the central channels of the Neches River and Pine Island Bayou, plus north to Village Creek and west to the mouth of Cook's Lake. Prohibit PWC use in oxbows and other backwater areas.	Entire unit closed to PWC use
Engine Type	No restriction.	Require only four-stroke engines (phased)	Not applicable.
Use Hours	Sunrise to sunset.	From three hours after sunrise to one hour before sunset.	Not applicable
PWC Numbers	No limits.	No limits	None
PWC User Education	None.	Educate PWC users about restrictions, safe operation, etc.	Not applicable
State Regulations	Enforce all state regulations.	Enforce all state regulations	Not applicable.

TABLE 2: SUMMARY OF ENVIRONMENTAL CONSEQUENCES

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
Water Quality	Impacts from PWC-related PAHs selected for analysis and benzene in the main river channel would be negligible to minor in both 2002 and 2012. In backwater areas in 2002 impacts from benzene could be moderate to potentially major based on human health benchmarks (because there is much less water volume and also less mixing or dilution), and minor based on ecological benchmarks. In 2012, assuming that the emissions of hydrocarbons from newer engines are half that of older models, impacts from all hydrocarbons to water quality in backwater areas would be negligible to minor, based on both human health and ecological benchmarks. Under the cumulative evaluation for personal watercraft and motorized boats to water quality in the river, in 2002 impacts would be negligible for all the compounds except benzene, based on the human health benchmark. Cumulative human-health based impacts to water quality in the river from emissions of benzene from boats could be moderate to potentially	Impacts from PWC-related PAHs that were analyzed and benzene in the main river channel would be negligible to minor in both 2002 and 2012. Reduced PWC emissions by 2012 from phasing-in four-stroke engines would result in negligible impacts to water quality in the river. In backwater areas, no impacts to aquatic biota or human health would occur since PWC use would not be permitted in these areas under this alternative. Cumulative impacts would be similar to alternative A, except that the PWC-related incremental contribution to cumulative effects would be eliminated in backwater areas. This would be a beneficial impact to water quality. Alternative B would not result in impairment to water quality.	Impacts from personal watercraft would cease. This would be a beneficial impact to water quality. This alternative would not result in impairment to water quality.

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
	major in 2002, based on the estimations performed for this assessment. The incremental impact of PWC use on the river would be minor. Cumulative impacts would be reduced to moderate in 2012 because it is expected that more four-stroke engines would be used, in accordance with the EPA requirements. In backwater areas, impacts from benzene would be moderate and possibly major in 2002 and moderate in 2012. The PWC-related incremental contribution to cumulative impacts would be negligible to minor. Alternative A would not result in impairment to water quality.		
Air Quality			
• Impacts to Human Health from Airborne Pollutants	For ozone there would be a moderate impact in 2002 and a minor impact in 2012 under alternative A. (For 2002 the ozone standard could be exceeded once, the same as for year 2000, and VOC emissions could exceed 5 tons per year. For 2012 it is possible that the ozone standard could be exceeded, but emissions are predicted to be less than 5 tons per year.) Negligible impacts are predicted for all other criteria pollutants based on identified impact thresholds (emissions would not exceed 50 tons per year between 2002 and 2012). Emission of any quantity of ozone precursor pollutants below 5 tons per year while the area remained out of attainment with the 1-hour ozone standard would result in a minor impact for that particular pollutant. Cumulative impacts for ozone would be considered moderate while the area remained in non-attainment status. For all other criteria pollutants impacts would be minor and trending toward negligible once attainment status was achieved and improved emission controls were phased in. PWC contribution to these cumulative impacts would be very small. This alternative would not result in impairment to air quality.	Alternative B would result in similar but slightly reduced impact levels compared to those described for alternative A. Accelerating the phase in of four-stroke engines would be beneficial to the preserve's air quality objectives. Pollutants such as THC and VOC are emitted in greater quantities by two-stroke as opposed to four-strike engines; therefore, emissions of these pollutants would be reduced over the period leading up to 2012, compared to alternative A. Cumulative impacts would be very similar to those for alternative A and would be considered moderate while the area remained in non-attainment status for ozone, and minor trending toward negligible for other pollutants once attainment status was achieved and improved emission controls were phased in. PWC contribution to cumulative impacts on air quality would be reduced and remain small. This alternative would not result in impairment to air quality.	Banning PWC use would result in a beneficial impact to air quality. PWC-related contribution to cumulative air quality impacts would be eliminated. Cumulative impacts from all other sources would be similar to alternative A. This alternative would not result in impairment to air quality.
• Impacts to Air Quality Related Values	Ozone impacts on plants would be moderate from 2002 through 2012, and visibility impacts would be negligible. Cumulative impacts would be considered moderate for ozone effects on plants and minor for visibility. This alternative would not result in	Impact levels would be similar to, but slightly reduced from, alternative A. Cumulative impacts would similar to, but slightly reduced from, those described for alternative A. This alternative would not result in impairment to air quality related values.	Banning PWC use would eliminate this source of emissions, resulting in a beneficial impact to air quality resources. PWC contribution to cumulative air quality impacts would be eliminated. Cumulative impacts from other motorized boats would be the same as alternative A.

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
	impairment to air quality related values.		This alternative would not result in impairment to air quality related values.
Soundscapes	Continued PWC use would result in minor to moderate adverse noise impacts in the lower Neches River portion of the study area during times of high PWC use (i.e., 26 days a year). During other times, noise impacts associated with PWC would be minor to negligible. Visitors such as anglers who use the lower Neches River area for quiet pursuits could be adversely affected by PWC noise, depending on location and duration of the impact. Other visitors along the lower Neches River are primarily motorized watercraft users who would not be affected to a large degree because their vehicles produce similar noise levels. On a cumulative basis impacts would be adverse and continue at minor to moderate levels over the next 10 years due to the continuation of additional noise sources in the project area, such as motorboats and automobile traffic. The incremental impact of continuing PWC use would be minor. The soundscape would not be impaired under alternative A.	Noise generated by PWC use would be reduced from alternative A because of restrictions on times and areas of use. Visitors, such as anglers, who use the area for quiet recreational pursuits would especially benefit from the additional PWC time and location restrictions. Other visitors along the lower Neches River are primarily motorized watercraft users who would not be affected, because their motors produce similar noise levels. Overall, impacts would be short term and minor to moderate in intensity. On a cumulative basis impacts would be adverse and continue at minor to moderate levels over the next 10 years due to the continuation of additional noise sources in the project area, such as motorboats and automobile traffic. Incremental impacts from PWC use to backwater area soundscape would be eliminated, but remain minor along the river corridor. The soundscape would not be impaired under alternative B.	Eliminating PWC noise would be beneficial to the soundscape to some degree. Because many of the other visitors along the lower Neches River are also motorized watercraft users, the overall reduction in noise resulting from banning personal watercraft would be relatively small, but this reduction would benefit the visitors who are most bothered by PWC noise levels and changes in pitch that are typical of their operation. On a cumulative basis impacts from all other sources would continue at minor to moderate levels, but PWC incremental impacts to these cumulative effects on the soundscape would be eliminated. The soundscape would not be impaired under the no-action alternative.
Wildlife and Wildlife Habitat	Continued PWC use in all areas along the lower Neches River could result in minor to moderate direct and indirect adverse impacts on wildlife and waterfowl from PWC-generated noise, physical disturbance, and emissions. Cumulative adverse impacts would be minor to moderate, and they would be limited to the time during which the disturbance occurred. PWC contribution to these cumulative effects would be negligible. No impairment would occur to fish or wildlife resources.	Compared to alternative A, alternative B would have some beneficial effect to wildlife and waterfowl from a reduction in PWC-generated noise at certain times and in certain locations. Impacts to wildlife in backwater areas from PWC use would be eliminated. In general, adverse impacts to most fish and wildlife species from PWC use would be negligible to minor. Cumulative impacts would be similar to, but slightly less than, alternative A due to prohibiting PWC use in backwater areas and during early morning and dusk, thus limiting impacts to those areas and during those times when wildlife are most abundant or most vulnerable. This would most likely have a beneficial impact on wildlife. No impairment would occur to fish or wildlife resources.	Impacts to wildlife and waterfowl would be beneficial due to banning PWC use. The minor reduction in noise could positively affect wildlife, particularly in areas of frequent PWC use, resulting in potential reinhabitation or use of these areas by wildlife and waterfowl. PWC contribution to cumulative impacts on fish and wildlife would be eliminated. Cumulative impacts would be similar to alternative A from other sources of impacts. No impairment would occur to fish or wildlife resources.
Threatened or Endangered Species or Species of Special Concern	Actions may affect, but are not likely to adversely affect, any of the listed species that are likely to occur or could possibly occur in the study area. While some adverse impacts could result from the activities analyzed, none of	Similar to alternative A except some adverse impacts would be mitigated under this alternative with the timing restrictions and the elimination of PWC use in backwater areas No impairment would occur to any	Banning PWC use would eliminate the potential for adverse affects on listed species, which would be a beneficial impact. Cumulative effects from other sources of impacts would be similar to alternative A.

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
	these impacts would be of sufficient duration or intensity to cause anything except short-term effects on the listed species. This conclusion is valid for both PWC actions alone and cumulative effects that include other actions. There would be no impairment to any listed species expected to occur in the preserve.	listed species under this alternative.	No impairment would occur to any of the listed species.
Shorelines and Shoreline Vegetation	Impacts to shorelines and shoreline vegetation from PWC use would be negligible, given the nature of the shoreline (which deters landings), the relatively few number of personal watercraft used on the river, and the way in which they are used (primarily in the main channel/open areas). Cumulative impacts would include effects from other motorized craft and the flooding regime on the river and would be considered minor to moderate, depending on the level and frequency of flooding. No impairment to shorelines or shoreline vegetation would occur.	Impacts to shorelines and shoreline vegetation would be negligible, since PWC use would be restricted to the main river channel. Banning PWC in backwater areas would eliminate potential impacts to many of the smaller marshes that are more common in stiller, shallow waters, which would be beneficial to these resources. PWC-related contributions to cumulative impacts to backwater areas would be eliminated. Overall, cumulative impacts would be minor to moderate, depending mostly on the flooding regime imposed by upstream dam releases and natural floods No impairment to shorelines or shoreline vegetation would occur.	PWC-related impacts would cease, resulting in some beneficial effects to shorelines and shoreline vegetation, especially in backwater areas. Cumulative impacts from other sources would be similar to alternative A except PWC contribution to cumulative impacts would be eliminated. No impairment to shorelines or shoreline vegetation would occur.
Visitor Use and Experience	There would be no impact to those continuing to use PWC while visiting the preserve to experience park resources and values. For other park visitors, especially anglers who desire to experience park resources and values without conflict from PWC use in the early morning hours, there would be minor to moderate, long-term impacts since these uses would continue. The continued use of personal watercraft and motorized boats would likely have long-term, minor cumulative impacts to overall visitor use and experience of park resources. However, impacts to some park visitors who desire to experience park resources without conflict from motorized recreational uses, including PWC use, would continue at a moderate level over the long term.	No longer allowing PWC use in backwater areas and limiting times of use would affect those visitors who come to the preserve to experience park resources and values on their personal watercraft. However, because most PWC users already avoid these areas and generally use their watercraft later in the day, adverse impacts would be minor. PWC owners of non-compliant two-stroke engines would eventually be banned from the area, and the impacts to those individuals would be minor to moderate; however, use of the river by other means would not be precluded. For those visitors who enjoy fishing and other quiet activities, there would be a beneficial impact because potential conflicts between PWC use and other visitors would be reduced. Cumulative impacts would be essentially the same as alternative A, with reduced incremental impacts from PWC use to anglers, backwater users, and others who pursue more passive experiences while visiting the preserve. Cumulative impacts overall would be minor.	Minor to moderate impacts would occur to those visitors using personal watercraft to experience park resources and values. For those who visit the preserve to experience park resources and values in more passive ways (fishing, non-motorized uses) there would be a long-term, beneficial impact since conflicts between PWC and these other uses would be eliminated. Other motorized boating would continue in the preserve, with the exception of personal watercraft. Given the low volume of PWC use that would be precluded from overall park visitation, impacts would be minor.

Impact Topic	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
Visitor Safety	Impacts to visitor safety would be negligible because the existing relatively safe conditions associated with low levels of PWC use would continue. This alternative would pose some safety risks because all existing recreational uses would continue. Cumulative impacts would be negligible to minor.	This alternative would have a beneficial impact simply by reducing the potential for accidents. Safety would be enhanced to a minor degree by restricting PWC use on the river at certain times, banning PWC use in backwater areas, and providing educational materials. Cumulative impacts would be similar to, but slightly reduced from, those for alternative A.	There would be beneficial impacts to visitor safety since personal watercraft would no longer be allowed to operate in the preserve. Eliminating personal watercraft would reduce the potential for PWC-related accidents, although cumulative impacts from other uses would affect visitor safety to a minor degree.
Cultural Resources	There would be negligible impacts to cultural resources. Although the potential for finding cultural resources in the area of PWC use is already small, there is a slightly increased possibility of visitors discovering or harming cultural resources due to the continued use of the area by PWC recreationists. Because of impacts related to other park users, cumulative impacts would be minor to moderate. Alternative A would not result in impairment to cultural resources.	Although the potential for finding cultural resources in the study area is small, alternative B would have a slightly decreased possibility of visitors discovering or disturbing cultural resources in backwater areas. Overall impacts would be negligible. Cumulative impacts would be minor to moderate, based on the negligible impacts of alternative B combined with other park users in potentially culturally sensitive areas. Alternative B would not result in impairment to cultural resources.	Banning PWC use would further limit the potential for cultural resource discovery or disturbance by visitors due to the ban of PWC users in the area, resulting in a negligible impact. Cumulative impacts would be minor to moderate from other park users in potentially culturally sensitive areas. Incremental impacts from PWC use would be eliminated. The no-action alternative would not result in impairment to cultural resources.
Socioeconomic Effects	There would be negligible to minor economic and social impacts overall to user groups and businesses.	There would be minor to moderate economic and social impacts overall to user groups and businesses.	There would be minor to moderate economic and social impacts overall to user groups and businesses.
Preserve Management and Operations			
Conflicts with State and Local Regulations	Continuing PWC use would not result in conflict with state PWC regulations or policies, and there are no local regulations. Therefore, impacts (including cumulative impacts) related to such conflicts would be negligible.	Any changes in PWC regulations under alternative B would not result in conflicts with state PWC regulations or policies, and there are no local regulations. Therefore, impacts related to such conflicts (including cumulative impacts) would be negligible.	Any change in PWC regulations within Big Thicket, including banning PWC use, would not result in conflicts with state PWC regulations or policies, and there are no local PWC regulations. Therefore, impacts related to such conflicts (including cumulative impacts) would be negligible.
Preserve Operations and Increased Enforcement Needs	There would be negligible impacts to preserve operations because regulations relating to PWC use would continue to be enforced.	There would be short-term, minor to moderate adverse impacts on preserve operations due to the additional duties that would be required by NPS staff to implement and enforce the new PWC regulations and to educate visitors. Cumulative impacts would be minor, as more visitors became aware of the restrictions included in this alternative.	There initially would be minor to moderate, short-term impacts from enforcement of the PWC ban Over the long term there could be slight beneficial impacts to national preserve operations because staff would have some additional time to focus on other activities. Cumulative impacts would continue, but PWC-related contributions to these impacts would be eliminated.

AFFECTED ENVIRONMENT

The topics covered in this chapter and the "Environmental Consequences" chapter are those resources of Big Thicket National Preserve that would potentially be affected by the implementation of any alternative being considered in this environmental assessment. The topics are

- water quality
- air quality
- soundscapes
- wildlife and wildlife habitat
- threatened or endangered species or species of special concern
- shorelines and shoreline vegetation
- visitor experience, and visitor safety and conflicts
- cultural resources
- socioeconomic environment
- preserve management and operations

Impact topics that were deleted from further consideration are discussed beginning on page 17.

GENERAL PROJECT SETTING

The Big Thicket area of east Texas originally covered an area of approximately 3.5 million acres. It is still characterized by diverse and beautiful vegetation and extensive water-based resources. Variations in geology, climate, soils, elevation, and drainage have resulted in the biological diversity of the area. Land uses in the region, though benefiting the area economy, have reduced the Big Thicket to mere remnants of its former extent. The national preserve was established to ensure the preservation, conservation, and protection of a portion of this once great forest complex.

The Big Thicket, often referred to as a "biological crossroads," is a transition zone where southeastern swamps, eastern deciduous forest, central plains, pine savannas, and dry sandhills meet and intermingle. The area provides habitat for rare species and favors unusual combinations of plants and animals. The Neches River is the primary drainage of the national preserve, capturing the majority of water from precipitation and overland flow.

In recognition of its diversity, the national preserve was designated a biosphere reserve in 1978 by UNESCO. It shares this distinction among 337 biosphere reserves in 85 countries worldwide. A biosphere reserve is a place for long-term study of changes in the physical, biological, and human environment. It conserves the natural resources and special natural qualities of its region (U.S. Department of State 1996).

The national preserve contains 15 separate units, comprising 96,804 acres (see the Location map on page 3). The 15 units of the national preserve lie in east Texas, north of Beaumont and northeast of Houston, and occupy portions of Hardin, Liberty, Orange, Jasper, Polk, Tyler and Jefferson Counties. PWC use is restricted to a relatively small portion of the entire national preserve: the Neches River

south of its confluence with Village Creek, and Pine Island Bayou up to the mouth of Cook's Lake. This area falls within the Beaumont Unit and the southern tip of the Lower Neches River Corridor Unit and includes parts of Orange, Hardin, and Jefferson Counties.

WATER QUALITY

Water is one of the primary resources in the national preserve. Most of the national preserve units either contain or are adjacent to large, perennial streams. In addition to these major river/stream reaches, the national preserve contains a wide variety of minor hydrologic features: floodplains, sloughs, oxbows, baygalls, acid bogs, and low-order tributary streams. All units of the national preserve are within the watershed or basin of the Neches River, except for the Menard Creek Corridor Unit, which is in the Trinity River basin. Both of these drainage basins trend to the southeast and have gentle slopes with channels that meander from their headwaters to the Gulf of Mexico.

NECHES RIVER WATER QUALITY

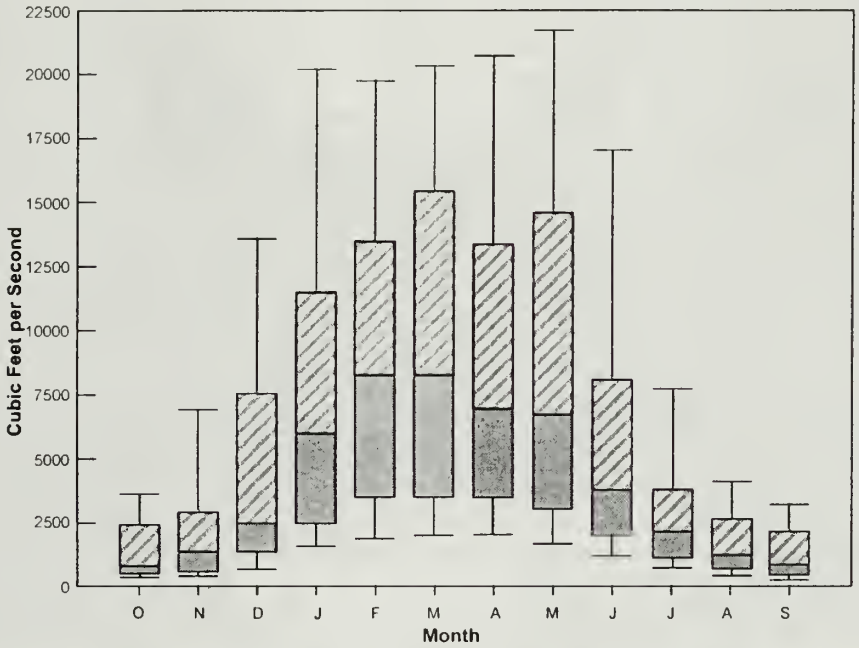
The primary focus of this section is the water quality of the Neches River, especially in the area where personal watercraft are permitted (see the PWC use area shown on the Alternative A map). The entire Neches River basin is roughly 200 miles long by 50 miles wide, draining an area of approximately 10,000 square miles. The Angelina River drains the northern third of the basin, while the Neches drains the remaining two-thirds before entering the Gulf of Mexico through Sabine Lake, southwest of Beaumont. Major tributaries to the Neches within the national preserve are Big Sandy Creek/Village Creek, Turkey Creek, Pine Island and Little Pine Island Bayous, Hickory Creek, and Beech Creek (see the Location map).

The Neches is a large, meandering river with regulated flow. It also shares certain similarities with blackwater rivers, a subset of coastal plain rivers of the southeastern United States, since it connects to many unnamed creeks and sloughs that affect both the hydrology and hydrochemistry of the surface water environment. Sloughs channel and capture water. They are located within the active floodplain and therefore are subject to a great degree of hydrologic exchange with mainstem drainages. In addition to the periodic input of floodwaters, sloughs may receive sediments during floods. Water quality in sloughs can vary from that observed in the mainstem watercourse to that more typical of acid bogs, depending on the elapsed time between flood events (NPS 2001c).

The tidal portion of the Neches River watershed extends from the confluence with Sabine Lake upstream into the southeast portion of the Beaumont Unit. Flows in the river downstream of this area are influenced by tides, water quality of the ocean, and discharges from the upper watershed. The tidal segment is highly developed and industrialized; it is dredged to maintain a navigation channel.

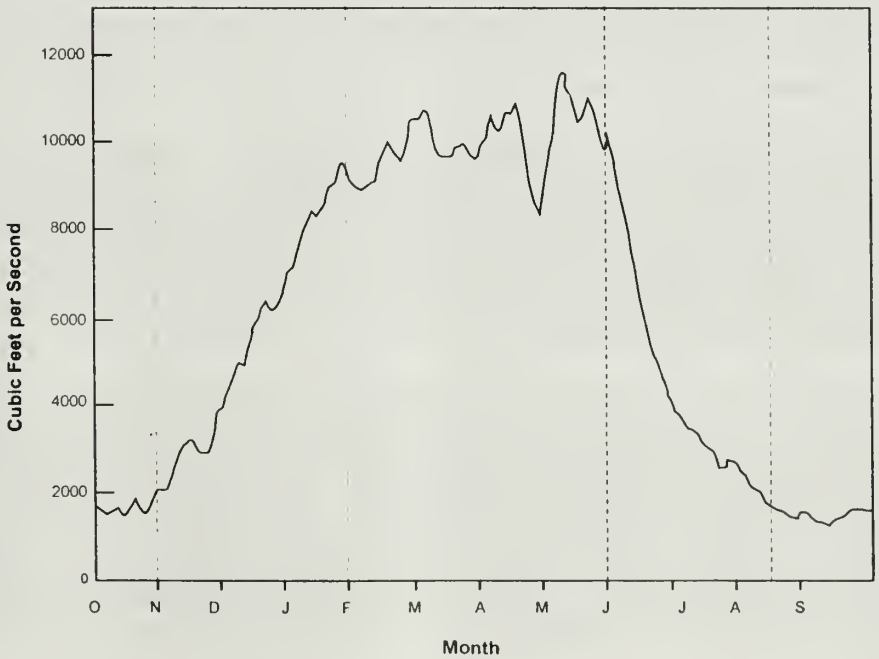
Flow Characteristics Affecting Water Quality. Flow characteristics strongly affect the water quality in the Neches River, since flow influences dilution, transports contaminants from upstream sources, and determines the extent of saltwater intrusion. Both the U. S. Geological Survey and the National Weather Service operate a number of stream gages within the Neches River basin. Analysis of the 71-year flow record from the USGS gage at Evadale on the Neches River indicates that peak flows generally occur between February and June, and that 90% of these peaks are below 22,500 cubic feet per second (NPS 1995a; see Neches River Representative Mean Annual Hydrograph and Distribution of Daily Flows).

REPRESENTATIVE MEAN ANNUAL HYDROGRAPH



Note: Horizontal lines show 10th to 90th percentile; boxes show 25th to 75th percentile, internal line is the median
Source: 71 Year Record at Evadale, TX

DISTRIBUTION OF DAILY FLOWS



Source: 71 Year Record at Evadale, TX

Within the Neches River basin are two major impoundments within 30 river miles upstream of the national preserve. The timing of and releases from these reservoirs affect downstream water quality. B. A. Steinhagen Lake is upstream of the Upper Neches River Corridor Unit and normally occupies 16,800 surface acres. Sam Rayburn Reservoir, the larger of the two, is on the Angelina River about 25 miles above the confluence of the Neches and Angelina Rivers. It includes parts of five counties and occupies 114,500 surface acres (at normal level). At Steinhagen, Town Bluff Dam (known as Dam B) serves to control the release of water from Rayburn. When operated in conjunction with the dam at Rayburn, Steinhagen's surface acreage normally ranges between 11,000 and 14,000 acres. Both dams are operated by the Fort Worth District of the Army Corps of Engineers (NPS 2001c).

The construction and subsequent operation of these reservoirs have altered the flow characteristics of the Neches River by reducing the frequency and duration of both high and low flows (Gooch 1996; Hall 1996). Changes in the duration and frequency of floods have also resulted in changes in species composition and distribution of floodplain forest communities (Hall 1996).

In addition to the control of these reservoirs, water diversion may also alter the natural flow and behavior of a river or stream. A number of water diversions exist within the Neches River basin, including the LNVA canal and the city of Beaumont drinking water intake. However, an analysis of basin diversions concluded that the amount of water annually diverted is relatively small compared to annual fluctuations (NPS 2001c).

Finally, flow in the Neches can be influenced by saltwater barriers used to protect the LNVA freshwater diversion points when the Sam Rayburn Reservoir water levels are low. Temporary barriers have been installed over the years, and there is a breached barrier in the Neches River south of the Lakeview sandbar area. A new permanent barrier is being constructed about 0.5 mile south of the national preserve boundary (south of the Confluence boat launch).

State-Designated Stream Segments and Uses. In accordance with EPA guidelines, the Texas Natural Resource Conservation Committee (TNRCC) has classified major stream segments within the state according to designated uses. In order to support or achieve the designated uses of these stream segments, the committee has promulgated specific numerical criteria for each use and each segment.

The area of PWC use includes portions of stream segments 601 and 602, as defined by the Texas Surface Water Quality Standards. Segment 602 consists of the Neches River below Steinhagen Lake and includes most of the area where personal watercraft are used. Village Creek and Pine Island Bayou are major tributaries to this segment. Segment 601 is the tidal portion of the Neches River, which extends from the confluence with Sabine Lake in Orange County upstream to a point 7 miles upstream from I-10 in Orange County (TNRCC 2002).

Designated uses for segment 602 are contact recreation, high quality aquatic habitat, and public water supply. Designated uses for segment 601 are contact recreation and intermediate aquatic habitat. The city of Beaumont operates three drinking water intakes on the Neches: one just south of Collier's Ferry (south of the national preserve), one at Bunn's Bluff about 0.5 mile north of the confluence with Pine Island Bayou, and one far north in Jasper County (Miller, pers. comm.). The Bunn's Bluff intake (Photo 1) is within the portion of the Neches used by personal watercraft. The Lower Neches Valley Authority also withdraws drinking water from the Neches River in this area. It operates several intakes on the LNVA canal, which connects the Neches River near the Lakeview sandbar to Pine Island Bayou west of Cook's Lake.

PHOTO 1: CITY OF BEAUMONT DRINKING WATER INTAKE (BUNN'S BLUFF)

Three permitted discharges exist along segment 602: two domestic outfalls and one industrial outfall (paper mill at Evadale). Along segment 601, accidental spills of oil and other contaminants from riverside industries or ships have occurred and continue to threaten water quality on an acute as well as a chronic basis (TNRCC 1996). Both segments 601 and 602 had been designated for many years as "water quality limited" or "impaired," due to fecal coliform and cadmium levels. However, as of 1998, both were delisted due to changes in the listing criteria, and now both segments officially support their designated uses (TNRCC 2002).

Antidegradation Policy. The state-established antidegradation policy is designed to protect water quality at existing levels and to prevent a deterioration of water quality below achievable uses for a given stream segment. The policy has three levels of protection: (1) existing uses will be maintained and protected; (2) for instream segments whose quality exceeds designated uses, degradation may only be allowed for important social and economic development; and (3) no degradation will be allowed for outstanding natural resource waters. No waters in the state are currently designated as an outstanding natural resource. For the Neches River, antidegradation means that existing uses should be maintained and protected.

Water Quality Data. A relatively large amount of water quality data have been gathered for standard pollutants in the preserve's major drainages. These data are essentially of two types: studies that were either very limited in space and/or time, or more comprehensive monitoring programs where the period of data collection spanned months or years and included numerous stations. Separate monitoring programs have been undertaken by both the U.S. Geological Survey and the National Park Service, and a detailed "Baseline Water Quality Data Inventory and Analysis" was published in 1995 that summarizes data available from five EPA national databases (NPS 1995a).

The National Park Service has established 15 water quality monitoring stations within six national preserve watersheds or subwatersheds: Beech Creek, Mill Creek, Big Sandy Creek/Village Creek,

Black Creek, Menard Creek, and Pine Island Bayou. Additionally, there are five water quality stations on the main stem of the Neches River. Between 1984 and 1994 nearly monthly measurements were made at 14 of the 20 stations, resulting in 1,781 records of field parameters and 678 records of lab parameters (Hall and Bruce 1996).

Very few monitoring programs have examined the primary pollutants of concern related to PWC use. However, past evaluations of baseline chemistry for the Neches River in the area where PWC use occurs indicate that some EPA water quality criteria (zinc, cadmium, copper, and lead) have been exceeded, and farther downstream the criteria for turbidity, pH, dissolved oxygen, chlorides, sulfates, and fecal coliform have been exceeded.

The 1995 summary includes data specifically from stations in the area where PWC use occurs (NPS 1995a). These are stations 5 through 10 and 13, shown on the Water Quality Monitoring Stations map. An examination of the EPA water quality criteria analysis for stations 5, 9, and 13 shows that the turbidity criterion was frequently exceeded (an average Secchi disc depth of about 0.4 meter, which indicates that the water is not very clear in this area). Water quality criteria for dissolved oxygen, zinc, chloride, sulfate, cadmium, copper, and lead were also exceeded at least once. Hydrocarbon samples were taken only at stations 8 and 9 in 1980. The older data show that all the hydrocarbons tested were below the detection limit used at that time.

The city of Beaumont withdraws water from the Neches River in the area of PWC use at its Bunn's Bluff intake. However, the city does not test its raw water, so no data are available from the city treatment plant. The city does test its treated water, and there have been no volatile or semi-volatile organics found above detection limits (Miller, pers. comm.).

The data available show that there are many possible sources of adverse impacts to the aquatic community of the Neches River, in addition to PWC-related pollutants. A number of adverse impacts to water quality in the Neches River are likely related to human activities such as residential development, industrial discharges, and oil and gas exploration. There have been exceedances of standards for fecal coliform, dissolved oxygen (DO), metals, salinity, and dioxin. In the early 1990s, concerns about dioxin levels resulted in the issuance of a fish consumption advisory for the lower Neches below Highway 96 at Evadale. This advisory was removed in 1995, after sampling results showed dioxin levels were below the acceptable level of risk (Harcombe and Calloway 1997). Several studies have indicated that the saltwater intrusion and industrial pollution carried into the Neches River decrease the habitat value of the lower reaches of the river for benthic communities (NPS 2001c).

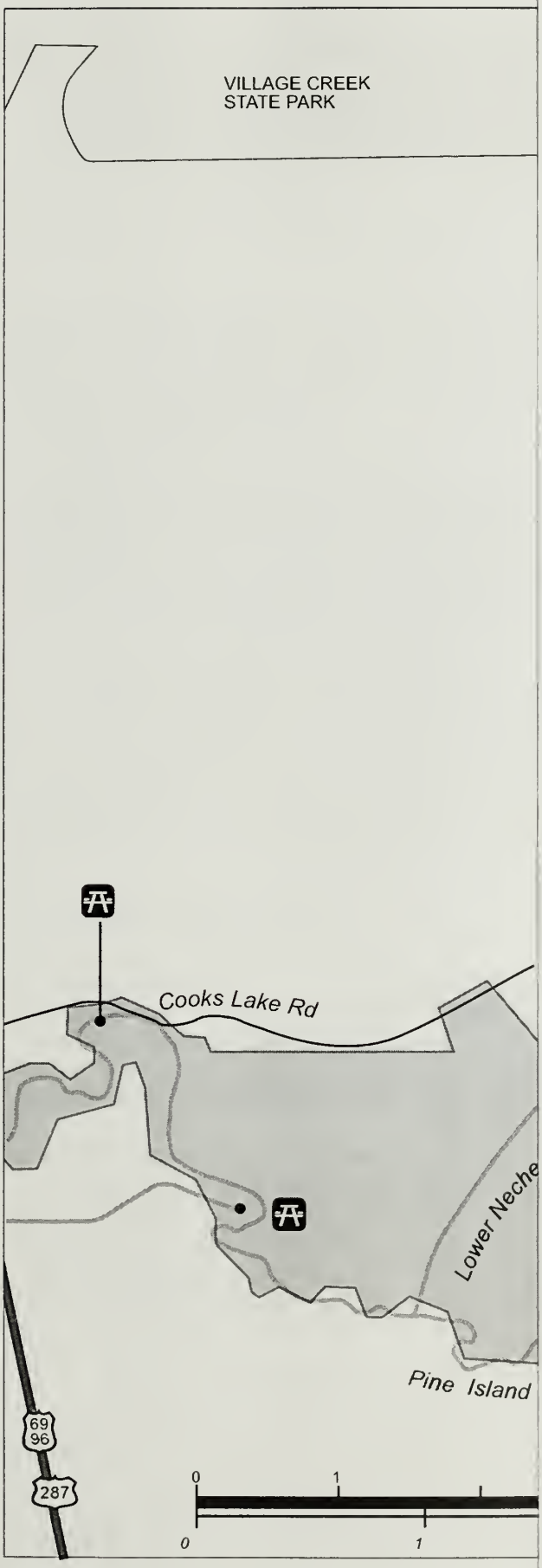
PINE ISLAND BAYOU WATER QUALITY

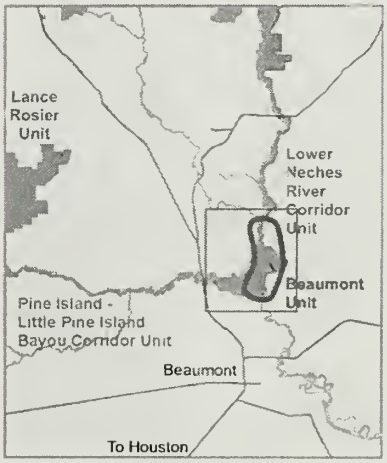
The entire Pine Island Bayou watershed drains about 657 square miles before its confluence with the Neches River. The watershed is largely wooded but also contains substantial industrial and residential development. The watershed slopes in a southeasterly direction and varies in elevation from about 2 feet (above mean sea level) at the confluence to about 160 feet at the watershed divide (U.S. Army Corps of Engineers 1985). The only portion of Pine Island Bayou that is within the area of PWC use is the area from the mouth of Cook's Lake downstream to the confluence with the Neches River, a distance of less than 1 mile.

Big Thicket National Preserve

Texas

Water Quality Monitoring Locations

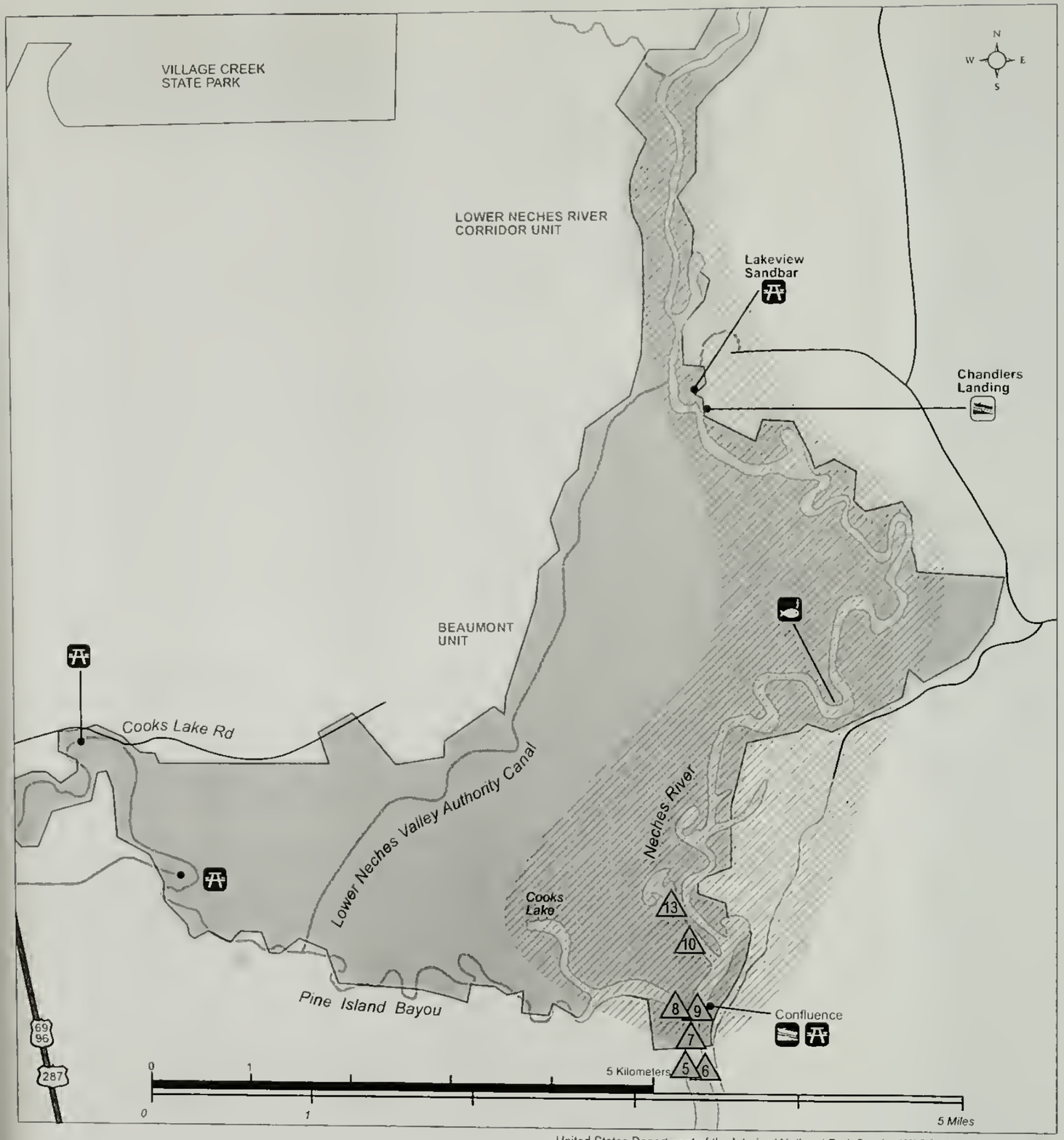


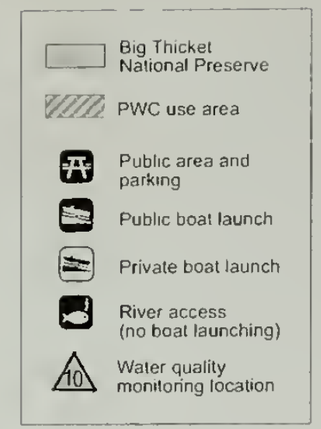


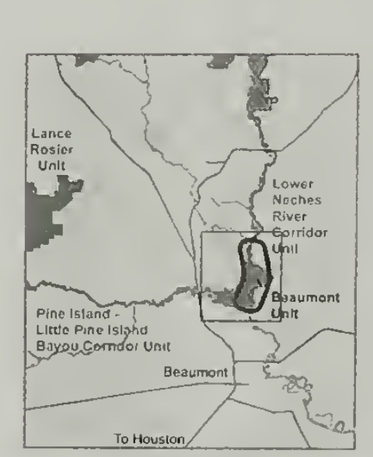
Big Thicket National Preserve

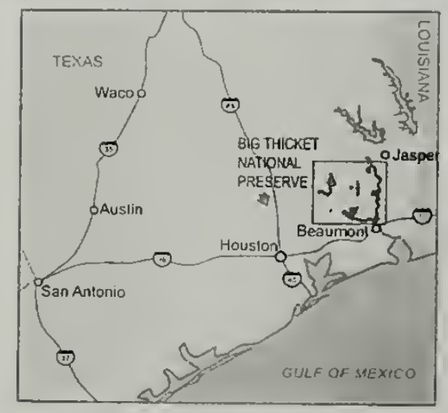
Texas

Water Quality Monitoring Locations









United States Department of the Interior / National Park Service WASO / April '02 / 175/20108

Stream Segments, Uses, and Permits. The portion of Pine Island Bayou considered in this environmental assessment is part of stream segment 607, which extends upstream from the confluence with the Neches River. This segment is impaired in its upstream reaches due to depressed dissolved oxygen levels, but the portion within the park is not listed as impaired (TNRCC 2002). Designated uses for segment 607 are contact recreation, high quality aquatic habitat, and public water supply (TNRCC 2001a).

There are three discharges with National Pollutant Discharge Elimination System (NPDES) permits in the water corridor unit for sewage treatment plant effluent from Pinewood Estates, Bevil Oaks, and Lumberton. In 1992 eight NPDES municipal wastewater discharge permits were recorded for Pine Island Bayou for a total flow of 3.17 MGD. There are also 11 domestic outfalls into the bayou, for a total of 4.94 MGD (NPS 2001c).

Water Quality Data. Streams flowing through the Pine Island Bayou watershed are similar to other surface waters in southeastern Texas in that seasonal flows are variable and total dissolved solids (TDS) concentrations are relatively low. In addition to natural factors, land use practices in the watershed have influenced area water quality, generally contributing to its degradation. Water quality monitoring results have indicated that standards for chloride, dissolved oxygen, pH, and fecal coliform, all of which affect the health of the aquatic community, have been exceeded.

Most of these exceedances were found farther upstream from the area of PWC use. The 1995 NPS baseline water quality report (NPS 1995a) includes one station near the mouth of Pine Island Bayou, the primary area of PWC use (station 8). Data from this station (all from 1980) show no exceedances of water quality criteria or state standards for any of the organics or metals selected for sampling and analysis. No data are reported for standard parameters such as DO, turbidity, pH, or for pollutants that would come from personal watercraft, and no recent data are available for this site.

Sensitive Aquatic Systems

The entire Neches River watershed and Pine Island Bayou confluence area can be considered sensitive, since they support a wide variety of fish and wildlife that help support Big Thicket's designation as a biosphere reserve. The entire riparian fringe is a wetland (primarily bottomland hardwood, with occasional littoral marsh), and its importance in the support of the structure and function of the national preserve's ecosystem is recognized.

Perhaps the aquatic areas most sensitive to disturbance and decline in water quality are the backwaters and oxbow lakes that fringe the main channel of the Neches (Photo 2). These areas do not receive the amount of flushing and dilution as the main channel and contain lush, dense habitat that support fish, invertebrates, and wildlife. Because they are also more removed from most of the noise and physical disturbance associated with large boats, skiers, and other recreationists who use the open water channel areas, they provide a quieter area for wildlife nesting, foraging, and breeding.

PHOTO 2: BACKWATER OXBOW LAKE

AIR QUALITY

The national preserve is north of the Beaumont / Port Arthur / Orange airshed and northeast of the Houston/Galveston airshed. Because of the large amount of industry (especially petrochemical industry) and urbanization in the area, these are two of the most polluted airsheds in Texas and represent two of five non-attainment areas in Texas that exceed national ambient air quality standards (NAAQS) established by the Environmental Protection Agency for ozone. Ozone can be both phytotoxic (having damaging effects on some vegetation) and injurious to humans and wildlife. Existing ozone levels may be increased by additional emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs), the primary precursors to ozone formation.

The national preserve may also be influenced by air pollutants transported from the Lake Charles, Louisiana, petrochemical complex. The primary pollutants transported by airsheds affecting the national preserve are VOCs and NO_x. Other air pollutants that could affect the national preserve and public health and welfare include carbon monoxide, sulfur dioxide, and particulate matter (including heavy metals and lead).

During most of the year, prevailing air flow is from the southeast and the Gulf of Mexico, shifting to flow from the northwest during passages of major continental air masses (cold fronts) that generally occur in late fall, winter, and early spring. The airshed of the southern portions of the national preserve is also affected by air currents (inshore/offshore flows) from the Gulf of Mexico, with daily heating and cooling. These flow patterns are considered important because they transport various air pollutants from the nearby industrial and urban areas into the preserve.

Big Thicket National Preserve lies within the Beaumont / Port Arthur ozone non-attainment area, which includes Hardin, Orange, and Jefferson Counties. The area is in attainment with all other

national ambient air quality standards. The Beaumont / Port Arthur area did not meet an EPA 1999 deadline for attaining the 1-hour ozone standard. The Texas Natural Resource Conservation Commission subsequently submitted an attainment demonstration for the Beaumont / Port Arthur area that shows that the area is affected by ozone precursor pollutants transported southwest from the Houston / Galveston ozone non-attainment area. EPA approved the Beaumont / Port Arthur area's attainment demonstration on April, 19, 2000, based on an extensive transport and photochemical modeling analysis and associated control strategies. Under this plan, the 1-hour ozone standard must be met by November 15, 2007, or be classified as "serious."

The closest air monitoring stations to the national preserve are in Beaumont. The northernmost, station C54, does not report NO_x, NO_2, or ozone levels. The second station (CO2) is in south Beaumont and does regularly monitor SO_2, NO_x, NO_2, and ozone, plus wind and temperature parameters. The EPA AIRS database shows that air quality at this station has been in attainment with all national ambient air quality standards except ozone. Monitoring data for this site show that ozone levels exceeded the one-hour standard once in the year 2000, no times in 1999, and three times in 1998 (TNRCC ozone exceedance data, 2001). The one-hour ozone standard is violated when there are more than three exceedances over a three-year period.

In the fall of 1996 particulate matter (PM) was monitored in the national preserve as part of a special study by the Texas Natural Resource Conservation Committee, the National Park Service, and Mexico to increase understanding of the transport of pollution to the Big Bend area of Texas. The fine fraction of PM (i.e., particles less than 2.5 microns, or PM2.5) was measured due to the interest in the dramatic effect this particle size has on visibility. Of the 18 sites monitored on both sides of the U. S. – Mexico border, the national preserve measured the highest levels of PM2.5 during a two-month period. Preliminary study findings indicate that fine sulfate particles comprised a significant portion of the PM2.5 measured at the national preserve, and that air masses arriving at Big Bend National Park from the Big Thicket area contained some of the highest levels of PM2.5 and sulfur compounds (NPS 2001c).

Use of personal watercraft could contribute to PM2.5 formation through emissions of SO_2, NO_x, and VOCs that are transformed in the atmosphere to fine particulate matter. Mean 24-hour average levels for PM2.5 (16.5 micrograms [µg] per cubic meter) measured in the national preserve during 1996 indicate ambient concentrations that exceed the newly promulgated annual average national ambient air quality standard (15 µg per cubic meter). However, implementation of this standard was blocked by a 1999 federal court ruling. If the levels measured are sustained and the new standard is ever reinstated, the national preserve would also be classified as a non-attainment area for fine particle national ambient air quality standards under the proposed EPA standard (NPS 2001c).

The national preserve's fire management program, nonfederal oil and gas operations, and motorized vehicle/watercraft use could locally affect air quality in the preserve and the surrounding area. However, industrialization (primarily petrochemical and public utility industries) and urbanization contribute more appreciably to air quality in the seven-county area of the national preserve and airsheds, as described earlier.

SOUNDSCAPES

One of the preserve's natural resources is the natural soundscape, also referred to as "natural ambient sounds" or "natural quiet." The natural soundscape includes all of the naturally occurring sounds of the preserve, such as wind in the trees, calling birds, insects, as well as the quiet associated with still

nights. As a "biological crossroads" with an unusual combination of plants and animals, Big Thicket has an uncommonly rich mix of natural sounds, which is an important part of the ecological functioning of the area (e.g., animal communication, predator/prey interaction) as well as the visitor experience (e.g., bird calls, solitude, tranquillity).

"Noise" is defined as unwanted sound. Sounds are described as noise if they interfere with an activity or disturb the person hearing them. When evaluated against the natural soundscape, which is all the sounds of nature in the absence of any human sound, all human sound is considered "noise." This does not, however, imply that all human sounds are inappropriate or unacceptable; such evaluations must consider management guidance such as park purpose, management zoning, resource sensitivity, impacts from the activity, and similar factors.

Sound pressure levels are commonly measured in a logarithmic unit called a decibel (dB). The human ear is not equally sensitive to all sound frequencies, being generally less sensitive to very low and very high frequency sounds; therefore, the A-weighted decibel scale (dBA), which is calibrated to the human ear's response, is often used in impact analysis. Table 3 illustrates common sounds and their associated sound levels using this scale.

TABLE 3: SOUND LEVEL COMPARISON CHART

Decibels	How it Feels	Equivalent Sounds
140-160	Near permanent damage level from short exposure	Large caliber rifles (e.g., .243, 30-06)
130-140	Pain to ears	.22 caliber weapon
100	Very loud	Air compressor at 20'; garbage trucks and city buses
	Conversation stops	Power lawnmower; diesel truck at 25'
90	Intolerable for phone use	Steady flow of freeway traffic; 10 HP outboard motor; garbage disposal
80		Muffled personal watercraft at 50'; automatic dishwasher; vacuum cleaner
70		Drilling rig at 200'; window air conditioner outside at 2'
60	Quiet	Window air conditioner in room; normal conversation
50	Sleep interference	Quiet home in evening; drilling at 800 feet
		Bird calls
40		Library
30		Soft whisper
20		In a quiet house at midnight; leaves rustling

Note: Modified from Final Environmental Impact Statement, Miccosukee 3-1 Exploratory Well, Broward County, Florida (U.S Department of the Interior).

For the average human a 10 dB increase in the measured sound level is subjectively perceived as being twice as loud, and a 10 dB decrease is perceived as half as loud. The decibel change at which the average human would indicate that the sound is just perceptibly louder or perceptibly quieter is 3 dB. There is generally a 6 dB reduction in sound level for each doubling of distance from a noise source due to spherical spreading loss (e.g., if the sound level at 25 feet from a PWC was 86 dB, the sound level at 50 feet would be expected to be 80 dB, at 100 feet 74 dB, etc.).

Natural and Human Sound Levels

A sound study was conducted at Big Thicket in 1998 to provide a rationale for protecting natural sounds at the preserve. As part of this evaluation, sound levels were recorded and monitored at various locations, including sounds from both natural and human sources. The study showed that the natural ambient sound level for most of the preserve is typically low and is primarily due to wind aloft in the trees (Foch 1999).

In the 1998 study natural ambient sound levels were recorded at two sites near the study area defined for this environmental assessment. One site is in the Beaumont Unit on the LNVA canal north of Cook's Lake, just outside the study area; this site is typical of backwater areas along the Neches River. The natural ambient sound level recorded in this area was 40.2 dBA. The other sound monitoring site was in the Lower Neches River Corridor Unit on the river near Evadale; this station is also outside the immediate project area, but has similar uses to that of the lower Neches River where motorized watercraft use occurs. The natural ambient sound level (i.e., L_{90}) recorded at this station was 43.4 dBA.*

Natural ambient sound levels varied considerably due to localized insects, wind in trees, vegetation differences, etc. It should also be noted that the measurements were taken from canoes floating on the river segments, and that the lower Neches River measurements included considerable conversation, as well as motorized recreational activities. Sources of noise that affect sound levels throughout the preserve include automobiles, boat motors, personal watercraft, motorcycles, all-terrain vehicles, various types of equipment (e.g., tractors, log skidders, chainsaws, and lawn mowers), air conditioners, power lines and transformers, and firearms. The majority of these noise sources are generally localized or seasonal in duration, thereby creating only temporary changes in background sound levels. The primary source of noise that affects sound levels along the lower Neches River is motorized watercraft, including powerboats and personal watercraft. Noise from residences and other human activities such as oil and gas development are also present in that area. Noise from personal watercraft and motorized boats varies considerably due to speed, behavior (e.g., jumping, maneuvering), engine size and type, and muffling. While decibel levels of personal watercraft and motorboats operated at a constant speed are roughly comparable to noise from automobiles being operated at a constant speed, their frequency spectra can be very different resulting in significantly different audibility, and therefore impacts. Also, when personal watercraft or boats change speeds, jump into the air or accelerate, their generated noise levels may increase dramatically and may reach maximums well over 80 dBA.

Visitor Responses to PWC Noise

As with all national preserve resources, the opportunity to experience the natural soundscape is part of the visitor experience. The natural soundscape of the preserve contributes to a positive visitor experience and is a direct or indirect component of why many people visit the national preserve. However, many visitors enjoy recreational activities using motorized watercraft, and noise is a component of that activity; such visitors do not necessarily visit the preserve for solitude or the soundscape. Visitor surveys regarding PWC noise in relation to visitor experience have not been conducted; therefore, it is difficult to quantify how many visitors enjoy the park for the natural soundscape compared to how many enjoy motorized recreational activities, or if some visitors enjoy both motorized activities and the natural soundscape. Information used in the analysis primarily comes from park staff observations and reports of complaints made formally and informally to park rangers.

* The values indicated are L_{90} values, representing the sound level exceeded 90% of the time. This is the level specified in NPS *Director's Order #47* to use in estimating the natural ambient sound level when a single decibel descriptor is used.

Many factors affect how an individual responds to noise. Primary acoustical factors include the sound level, the distribution of sound levels across the frequency spectrum, and the duration (and other time-related factors such as how often it occurs, and timing sensitivity) of the sound. Secondary acoustical factors include the spectral complexity, sound level fluctuations, frequency fluctuation, rise-time of the noise, and localization of the noise source (Mestre Greve Associates 1992).

Non-acoustical factors also play a role in how an individual responds to sounds. Non-acoustical factors vary from the past experience and adaptability of an individual to the predictability of when a noise will occur. The listener's activity will also affect how he/she responds to noise.

Personal watercraft and outboard motors are similar in the actual noise level they generate (in terms of decibels), which is generally around 80 dB or less at 50 feet from a motorized boat or personal watercraft (PWIA n.d.) but can range from below 80 to as much as 102 dB (Sea-Doo 2000; Bluewater Network 2001). However, unlike motorboats, personal watercraft are highly maneuverable and are used for stunts and acrobatics, often resulting in quickly varying noise levels due to changes in acceleration and exposure of the jet exhaust when crossing waves. The frequent change in pitch and noise levels, especially if operated closer to land, make the noise from personal watercraft more noticeable to human ears (Asplund 2001).

WILDLIFE AND WILDLIFE HABITAT

The abundant and diverse vegetation of the national preserve supports aquatic and terrestrial habitats for a variety of fish and wildlife. Many studies of specific types of wildlife have been performed in the Big Thicket region over the past century. Some of the most thorough inventories were conducted shortly after the national preserve's establishment in 1974. The following section combines the results of these studies, literature reviews, and wildlife observations to describe fauna believed to inhabit the national preserve, with emphasis on those inhabiting the lower Neches River corridor. Rare, threatened, and endangered species of plants and animals are discussed beginning on page 49.

MAMMALS

Currently 60 species of mammals are either documented or believed to inhabit the national preserve. Several large species have been extirpated in Big Thicket due to factors such as habitat destruction and overhunting. These include the jaguar, ocelot, and red wolf (NPS 2001c). White-tailed deer and small mammals such as raccoons, opossums, bats, rabbits, squirrels, mice, voles, and rats are common along the riparian areas bordering the Neches River and Pine Island Bayou, where trees and other vegetation provide food and suitable habitat for denning, nesting, and cover (NPS 1974c).

BIRDS

Birds are the most visible and diverse group of vertebrate fauna in the national preserve, and 176 species have been documented to date. This figure is thought to be low because no comprehensive inventory of birds has even been performed (NPS 2001c). The national preserve lies on a major migratory flyway, and many species of birds are transient during spring and fall migrations. Birds found in Big Thicket predominantly consist of three categories: passerines (including many neotropical songbirds), raptors, and waterfowl. The abundance and variety of birds in Big Thicket contribute to one of the favorite visitor activities, bird watching. Birds that frequent the lower Neches

River corridor include a variety of ducks, gulls, herons, swallows, egrets, and sandpipers, plus osprey and wood stork. These birds use the open water and shoreline habitat, including the hardwood trees, for nesting and perch sites (NPS 2001c).

Reptiles and Amphibians

Approximately 85 species of reptiles and amphibians are believed to inhabit the national preserve (Harcombe et al. 1996). This figure represents roughly 33% of the 235 species of reptiles and amphibians in Texas. The most diverse group of reptiles in Big Thicket is snakes. Texas has 68 species of snakes, and half of these inhabit Big Thicket. Other types of reptiles include skinks, lizards, turtles, and the American alligator. Three types of amphibians, including frogs, toads, and salamanders, inhabit Big Thicket. The Neches River and Pine Island Bayou riparian areas represent prime habitat for most of these species.

Fish

Of all faunal groups in the national preserve, fish are perhaps the most thoroughly inventoried: 92 species are believed to inhabit national preserve waters. In small tributaries, the most abundant species of fish include minnows, darters, bass, and bullhead catfish. This pattern shifts in larger tributaries, which are dominated by channel, blue, and flathead catfish; sunfish; largemouth and spotted bass; and crappie. Also considered very common in the Neches River drainage are threadfin shad, mosquito fish, and certain chubs, shiners, minnows, and darters (NPS 2001c). Snags in the river and its backwater areas provide habitat and cover for these fish and for invertebrates, a primary food item for many fish species.

Invertebrates

A recent comprehensive inventory of invertebrates, which includes butterflies and moths, has documented over 1,800 species (Bordelon and Knudson 1999); this is believed to be the greatest species diversity in the contiguous United States. In aquatic environments, insects and mussels are the most thoroughly documented species. Comprehensive inventories in the Village Creek drainage have documented 249 species of common macroinvertebrates including dragonflies, caddisflies, mayflies, and stoneflies (NPS 2001c). It is expected that the Neches River and Pine Island Bayou would have similar species. Snags, in particular, are important habitat for these invertebrates.

Three species of aquatic insects are endemic to the Big Thicket region (Abbott et al. 1997), and two are candidates for federal listing. Thirty-four species of mussels, including the Texas heelsplitter, live in the Lower Neches River watershed (Howells 1996).

THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

The terms threatened and endangered describe the official federal status of certain species in Big Thicket National Preserve, as defined by the Endangered Species Act of 1973. The term candidate is used officially by the U.S. Fish and Wildlife Service (USFWS) when describing those species for which sufficient information is on file on the biological vulnerability and threats to support the issuance of a proposed rule to list, but rule issuance is precluded for some reason. No candidate species are currently believed to inhabit the national preserve. Species of concern are those species for

which listing may be warranted, but further biological research and field study are needed to clarify their conservation status. Texas has enacted regulations similar to the Endangered Species Act that confer threatened and endangered status to certain species inhabiting the state. NPS policies dictate that federal candidate species, species of concern, and state-listed threatened or endangered species are to be managed to the greatest extent possible as federally listed threatened or endangered species (NPS 1991). Therefore, these species are included in this discussion.

A consultation letter was sent to the U.S. Fish and Wildlife Service and a reply was sent on October 10, 2001 (see appendix B). The reply included county-based listings of species and suggested that attention be paid to potential disturbance of Texas trailing phlox and the paddlefish. Based on this information and preserve staff knowledge, a list of all federally listed and state listed species believed to occur permanently or transiently (such as migrating birds) in the national preserve (based on past inventories, existing and potential habitat, documented sightings, and professional judgement) was prepared and is presented in Table 4. Those that could be found or are likely to inhabit the area used by personal watercraft are discussed in more detail below. Much of the information presented is from

TABLE 4. STATE AND FEDERALLY LISTED CANDIDATE, THREATENED AND ENDANGERED SPECIES BELIEVED TO OCCUR IN BIG THICKET NATIONAL PRESERVE

Common Name	Latin Name	Potential for Occurrence	Federal Status	State Status
Birds:				
American Swallow-tailed Kite	*Elanoides forficatus*	*	N/L	T
Bachman's Sparrow	*Aimophila aestivalis*	0	N/L	T
Bald eagle	*Haliaeetus leucocephalus*	?	T	E
Peregrine Falcon	*Falco peregrinus anatum*	0	N/L	E
Peregrine Falcon	*Falco peregrinus tundrius*	*	N/L	T
Brown Pelican	*Pelicanus occidentalis*	?	E	E
Piping Plover	*Charadrius melodus*	?	T	E
Red-cockaded Woodpecker	*Picoides borealis*	0	E	E
White-faced Ibis	*Plegadis chihi*	?	N/L	T
Wood Stork	*Mycteria americana*	*	N/L	T
Fish:				
Blue Sucker	*Cycleptus elongatus*	0	N/L	T
Creek Chubsucker	*Erimyzon oblongus*	0	N/L	T
Paddlefish	*Polyodon spathula*	*	SOC	E
Insects:				
Caddisfly	*Phylocentropus harnsi*	?	SOC	N/L
Dragonfly	*Somatochlora margarita*	?	SOC	N/L
Mussel:				
Texas Heelsplitter	*Potamilus amphichaenus*	?	SOC	N/L
Mammals:				
Louisiana Black Bear	*Ursus americanus luteolus*	?	T	E
Rafinesque's Big-eared Bat	*Corynorhinus rafinesquii*	?	SOC	T
Southeastern Myotis Bat	*Myotis austroriparius*	?	SOC	N/L
Navasota Ladies'-Tresses	*Spiranthes parksii*	0	E	E
Slender Gay Feather	*Liatrus tenuis*	0	SOC	N/L
Texas Trailing Phlox	*Phlox nivalis var. texensis*	0	E	E
White Firewheel	*Gaillardia aestevalis var. winkleri*	0	SOC	N/L
Reptiles:				
Alligator Snapping Turtle	*Macroclemys temminckii*	*	N/L	T
Louisiana Pine Snake	*Pituophis melanoleucus ruthveni*	0	SOC	E
Northern Scarlet Snake	*Cemophora coccinea copei*	0	N/L	T
Smooth Green Snake	*Liochlorophis vernalis*	0	N/L	E
Texas Diamondback Terrapin	*Malaclemys terrapin littoralis*	?	SOC	N/L
Timber Rattlesnake	*Crotalus horridus*	?	N/L	T

Note: Status: E = Endangered, T = Threatened, SOC = Species of Concern, N/L = Not Listed.

? = could possibly occur in PWC use area.

* = likely to occur in PWC use area.

0 = not expected in PWC use area.

personal observations and knowledge of the national preserve staff, because inventories of flora and fauna at Big Thicket are incomplete. The remainder of the species listed are not expected in the PWC use area because of lack of habitat, known ranges, or documented occurrences in the national preserve.

Birds

American Swallow-Tailed Kites (*Elanoides forficatus*). American swallow-tailed kites (state threatened) are migratory raptors that inhabit bottomland hardwood forests along major river bottoms in the southeastern United States and winter in South America. Kites historically bred throughout the southeastern United States; however, populations have declined in recent years. According to Rappole and Blacklock (1994), kite populations are now considered rare and local in Louisiana, South Carolina, and Georgia; good populations of kites are now only found in Florida. A recent survey of swallow-tailed kites in east Texas (Shackelford and Simmons 1999) documented 277 sightings and only one nest. Most sightings of kites in the national preserve have been reported in spring and summer months along the mid and upper portions of the Neches River. Although no kite nests have been found, the routine sightings of this species along the Neches strongly suggest that it may be nesting in mature bottomland forests in or near the national preserve.

Bald Eagle (*Haliaeetus leucocephalus*). Although formerly common, bald eagles (federal threatened and state endangered) are rare residents in east Texas. They prefer large lakes and rivers with tall trees along the shoreline. Bald eagles have been sighted most frequently near McQueen's landing in the Upper Neches River Corridor Unit and at the confluence of Menard Creek and the Trinity River in the Menard Creek Corridor Unit, but bald eagles have also been seen along the lower Neches River.

Peregrine Falcon (*Falco peregrinus*). Two subspecies of peregrine falcon are found in Texas: the American peregrine (*Falco peregrinus anatum*) and the Arctic peregrine (*Falco peregrinus tundrius*). Both species were delisted on August 25, 1999, but remain listed by the state as endangered and threatened, respectively. The American peregrine is a resident of the Trans-Pecos region, including Big Bend National Park and the Chisos, Davis, and Guadalupe Mountain Ranges. Arctic peregrines migrate through Texas twice a year to and from their wintering areas in South America. They stop on the Texas coast to feed before continuing their migration. In Big Thicket, peregrines (most likely the arctic subspecies) have been documented along the Neches River and in or near the Turkey Creek and Hickory Creek Units during spring and fall migrations.

Brown Pelican (*Pelicanus occidentalis*). The brown pelican (state and federally listed as endangered) is an uncommon permanent resident of the Texas coast. National preserve staff have observed pelicans near the terminus of the Neches River at Sabine Lake and at High Island southeast of Port Arthur; however, no pelicans have been documented in the national preserve. Pelicans might venture up the Neches River into the Beaumont Unit of the national preserve, but this would be a rare occurrence.

Piping Plover (*Charadius melodus*). Piping plovers (federally threatened and state endangered) are uncommon winter residents along the Texas coast and are considered rare to casual transients in winter in the eastern third of the state. Piping plover habitat includes sand and gravel shorelines, river sandbars, and islands. No piping plovers have been documented in the national preserve; however, the lower Neches River provides a corridor for plovers to move inland from their coastal habitat. In addition, the large sandbars along the Neches River could provide nesting habitat.

White-Faced Ibis (*Plegadis chihi*). The white-faced ibis (state threatened) is predominantly a coastal species that inhabits a wide variety of freshwater and estuarine environments. The south Texas coast

appears to be the northern limit of the ibis's breeding range. This species is considered a rare transient in the eastern third of Texas during spring and fall migration (Rappole and Blacklock 1994), and it could be found in the national preserve. To date, no sightings of white-aced ibis have been documented in the national preserve.

Wood Stork (*Mycteria americana*). Wood storks (state threatened) have been seen in a variety of wetland and riverine locations throughout the national preserve, including along the Little Pine Island Bayou in the Lance Rosier Unit, the Beaumont Unit, and the Lower Neches River Corridor Unit. Storks in the national preserve are believed to be post-breeding transients from populations in southern Mexico. While these populations are considered stable, storks from separate breeding populations in Florida are listed as federally endangered due to habitat loss and low numbers. Storks may have bred historically in Texas, but no breeding populations are currently believed to exist. Preferred inland habitat includes large lakes and forested wetlands (Rappole and Blacklock 1994).

Fish

Paddlefish (*Polyodon spathula*). Paddlefish (federal species of concern) generally inhabit large rivers in the Mississippi River drainage and adjacent Gulf coastal plain. Paddlefish have been documented in the lower Neches River and at the confluence of the Neches River and Little Pine Island Bayou (Seidensticker 1994). Unlike most large riverine fish, paddlefish eat plankton, as opposed to other smaller fish. Paddlefish require cool temperatures, large flows, and gravel bottoms for spawning (Rosen and Hales 1981). The lower Neches River does not typically have sufficient flows and gravel substrate is uncommon, so spawning habitat is considered marginal. Nonetheless, the backwaters of the Neches could provide important feeding areas for paddlefish during the summer months. The Texas Parks and Wildlife Department recently developed a recovery plan for paddlefish in the Neches River; that plan includes annual stocking of paddlefish below Dam B on the upper Neches River corridor. The effectiveness of paddlefish recovery has yet to be documented.

Aquatic Invertebrates

Three species of aquatic invertebrates (all listed as federal species of concern) inhabit the national preserve: a caddisfly (*Phylocentropus harrisi*), a dragonfly (*Somatochlora margarita*), and a freshwater mussel (Texas heelsplitter; *Potamilus amphichaenus*). The Big Thicket emerald dragonfly is endemic to the Pineywoods region of east Texas. The caddisfly is endemic to the Gulf Coastal plain, and the Big Thicket region is near its western distributional limit. Little is known about the habitat preferences and locations of these species within the national preserve (Abbott and Stewart 1997). The Texas heelsplitter is a very rare mussel that has been found in the Neches River basin and most recently in Steinhagen Lake (Howells 1996). This mussel has never been documented in the national preserve, but the hydrologic connectivity of the Neches River and Steinhagen Lake makes its occurrence likely in the upper Neches and possibly in the lower Neches River.

Mammals

Only three listed mammals are believed to occur in or near to the national preserve: two species of bats and the Louisiana black bear.

Black Bear (*Ursus americanus* ssp. *luteolus*). The closest known reproducing populations of the Louisiana black bear (federal threatened and state endangered) is in the Atchafalaya Basin in

Louisiana. Occasional sightings of bears have been reported in east Texas, so occurrences of bears in the national preserve (especially wandering males) are possible. Two separate studies aimed at identifying potential habitat for black bear reintroduction have identified suitable habitat in the Neches Bottom / Jack Gore Baygall Unit (NPS 2001c: Epps 1997). This area could serve as core habitat for bears in the future through reintroduction efforts or expansion of existing populations in Louisiana. However, any reintroduction effort would require the active participation and support of a number of public and private land management agencies and the public to ensure the provision of sufficient habitat and to prevent poaching and other bear/human conflicts. Continued fragmentation of habitat in the Big Thicket and surrounding region could preclude the possibility of black bear reintroduction.

Rafinesque's Big-eared Bat (*Corynorhinus rafinesquii*). Rafinesque's big-eared bat (federal species of concern and state threatened) is easily distinguished from other bats by its immense ears. East Texas is considered the western distributional limit of this species. Preferred habitat for this species includes hollow trees, crevices behind bark, and dry leaves, although it is most frequently found in occupied and abandoned buildings (Davis 1974). A temporary roost was documented in the Little Pine Island Unit in 1995 (Horner and Maxey 1998), and occurrences elsewhere in the national preserve are likely (Schmidly et al. 1979).

Southeastern Myotis (*Myotis austroriparius*). The southeastern myotis (federal species of concern) is a rather small bat with dense, dull, woolly fur. This rare species reaches its western distributional limit in east Texas. In the Big Thicket region it is typically found in crevices between bridge timbers, culverts and drain pipes, structures, and hollow trees (Davis 1974). The bat is usually closely associated with water and often feeds over ponds and streams. It has been documented in the Beech Creek Unit, Neches Bottom / Jack Gore Baygall Unit, Lance Rosier Unit, and Loblolly Unit.

Reptiles

Alligator Snapping Turtle (*Macroclemys temminckii*). The alligator snapping turtle (state threatened) is considered one of the largest freshwater turtles in the world. It lives in deep, fresh waters with muddy bottoms (such as rivers, lakes, oxbows, and sloughs) and occasionally enters brackish water. The species is rare mainly due to international and domestic demand for its meat, although it has also declined as a result of habitat loss from reservoir construction, channelization of streams and rivers, placement of dredge spoil on riverbanks, recreational use of riverbanks and sandbars, removal of snags and water pollution (USFWS 1994; Ernst and Barbour 1972). Almost all of the units of the national preserve provide habitat for alligator snapping turtles. Alligator snappers have been documented in Turkey Creek, the Neches River, and Menard Creek. The Menard Creek specimen weighed 116 pounds and had a 26-inch diameter shell.

Texas Diamondback Terrapin (*Malaclemys terrapin littoralis*). The Texas diamondback terrapin (federal species of concern) generally inhabits brackish coastal areas, including tidal marshes, estuaries, and lagoons, and favors reedy marshes (University of Delaware 2001; University of Michigan 2001). Although it is unlikely to occur in the area of PWC use, it could possibly be seen in the more brackish areas of the lower Neches River corridor.

Timber Rattlesnake (*Crotalus horridus*). In the past, two subspecies of timber rattlesnake (state threatened) were believed to be in east Texas: the canebrake rattlesnake and the timber rattlesnake (Conant 1975). However, recent research suggests that the canebrake rattlesnake is simply a color variant and not a separate subspecies. Timber rattlesnakes have been documented in the Lance Rosier Unit, Turkey Creek Unit, and Big Sandy Unit and could possibly occur in the bottomland forests along the Neches River.

PLANTS

All listed plant species are fire-dependent upland species and/or known only in the upper Neches River area.

SHORELINES AND SHORELINE VEGETATION

Shoreline vegetation is very limited along the area of the Neches River and Pine Island Bayou where personal watercraft are used, where vegetation consists mainly of the root system of the trees and shrubs in the floodplain forest. Most banks are very sharp and do not support a vegetative community, and frequent flooding also limits the establishment of vegetation.

Most of the shoreline vegetation along the rivers where PWC use occurs is classified as floodplain hardwood forest, often generally referred to as bottomland hardwood forest (Photo 3). Dominant tree species in this type include sweetgum and water oak. Swamp cypress / tupelo forest can be found in secondary river and creek channels and along the fringe of oxbow lakes and sloughs throughout the floodplain forests of the national preserve. As the name implies, the dominant tree species are bald cypress and tupelo (NPS 2001c).

PHOTO 3: FLOODPLAIN FOREST (PINE ISLALND BAYOU)

In addition to the floodplain forests bordering the rivers, there are spotty occurrences of emergent plants along the shoreline (Photo 4). These palustrine emergent wetlands contain nonwoody aquatic plants such as rushes, arrowheads, sedges, grasses, vines, and other plants (NPS 2001c). Finally, there are several sandbars along the shoreline where vegetation is lacking immediately along the water/land boundary.

PHOTO 4: EMERGENT SHORELINE MARSH AND FLOODPLAIN FOREST

Erosion of streambanks occurs due to the water flow conditions in the river, especially the changes in flow from flooding and releases from upstream dams. The Neches is a very dynamic system, with flows that erode some areas and cause accretion in others. This natural meander process produces the sandbars and banks noticeable along this stretch of the Neches River (Photo 5).

PHOTO 5: SANDBAR ALONG NECHES RIVER SHORELINE

VISITOR USE AND EXPERIENCE

GENERAL WATERCRAFT USE

Watercraft use has occurred in Big Thicket prior to the time the national preserve was established in 1974. Watercraft at Big Thicket are primarily used for fishing and recreational boating, but are also used to access areas such as swim beaches and hunting locations, which are inaccessible via roads. A study conducted in May 1999 assessed what activities visitors were aware of at the preserve (Gulley 1999). For water-related activities, approximately 43% of visitors surveyed were aware that canoeing takes place at Big Thicket, while 34% knew about fishing, 22% about swimming, and 18% about motorized boating. Of all the activities mentioned in this survey, motorized boating was the least commonly known by visitors.

Observations made by staff at Big Thicket indicate that motorized watercraft use is not changing, while nonmotorized watercraft use is steadily increasing. Big Thicket estimates that roughly 70% of the watercraft used at the national preserve is motorized. The types of motorized watercraft, listed in order of relative abundance, include "John boats" (flat-bottomed boats), pleasure craft, bass boats, pontoon boats, and jet boats. Types of nonmotorized watercraft include canoes, kayaks, and an occasional pirogue.

Most of the water recreation in the area of the lower Neches River and Pine Island Bayou up to Cook's Lake is dominated by motorized watercraft used for pleasure and general recreation and fishing boats, with some PWC use. Motorized watercraft used for pleasure tend to travel along the Neches River corridor and use the river at all times during the day, while fishing boats tend to remain in one area and are present primarily during the morning hours when the other motorboats are not present. Other types of watercraft (including canoes) are rare in this area because there are designated canoe routes elsewhere in the preserve that are more conducive to nonmotorized watercraft. However, there is a backwater area off of Pine Island Bayou, not far from its confluence with the Neches River, where canoeing and bird watching occur.

Most water-dominated units at Big Thicket are not conducive to watercraft use due to inaccessibility or lack of established boat ramps. Seasonal waterflows, submerged obstructions, and temporary saltwater barriers occasionally restrict navigability of the Neches River. In addition, the characteristics of water within Big Thicket (alluvial river, bayous, sloughs, swamps, and small blackwater streams) dictate types of water activities and watercraft accessibility. Given this, watercraft use at Big Thicket most commonly occurs in the Pine Island Bayou, Village Creek, and along the Neches River in four units (Upper Neches River Corridor, Neches Bottom/Jack Gore Baygall, Lower Neches River Corridor, and Beaumont). A 1999 visitor-survey indicates that the Beaumont and Neches Bottom/Jack Gore Baygall Units are the preferred locations for watercraft users (Gulley 1999).

In addition, other areas close to Big Thicket facilitate watercraft access and use. To the north of the Upper Neches River Corridor Unit is Steinhagen Lake, a publicly used recreational area. Steinhagen Lake flows into Big Thicket along the Neches River; however, access between these two areas via watercraft is not possible due to the dam. Watercraft users can, however, access Big Thicket from Village Creek State Park just west of the Lower Neches River Corridor Unit. Other waterbodies in the general vicinity of Big Thicket that allow watercraft use include Rayburn Reservoir, Sabine Reservoir, and the southern extent of the Neches River.

Most motorized watercraft use at Big Thicket occurs in the Beaumont Unit, while canoes and other nonmotorized equipment occur predominantly in the Village Creek Corridor (expansion area);

motorized watercraft tend not to travel here, and there are established paddle routes. Exact numbers of watercraft used are not available at this time, since no formal survey has been conducted and no permits are required for watercraft use. Geographic limitations, which were based on existing use patterns, were established for PWC use in the Superintendent's Compendium in 1999 (see appendix A).

Public boat launches at Big Thicket are maintained by the National Park Service and allow free access to the preserve. Private boat launches along the Neches River are maintained by individual owners, who sometimes charge fees to use them. Each of the four units that support watercraft use along the Neches River has at least one boat ramp (public or private). The most commonly used boat ramps in or near Big Thicket include Collier's Ferry (public), which is just south of the Beaumont Unit at the end of Pine Street; Confluence (public), inside the preserve at the south end of the Beaumont Unit; Evadale, at the north end of the Lower Neches River Corridor Unit; and Steinhagen Lake, to the north of preserve boundaries. Photo 6 depicts the Collier's Ferry access point.

PHOTO 6: COLLIER'S FERRY BOAT LAUNCH

PWC Use

Personal watercraft were first introduced at Big Thicket in the early 1980s. Since then, observations staff at Big Thicket made during scoping meetings in May 2001 indicate that PWC use has grown steadily until recently, when the numbers of PWC users seem to have leveled off. An exact number of PWC users at Big Thicket is not available at this time because PWC users have not been specifically counted; however, Big Thicket staff estimate that personal watercraft account for about 5%–10% of the total number of watercraft at the park on an annual basis. Big Thicket staff have indicated that during a typical high-use weekend day, about 12 personal watercraft can be observed along the lower Neches River, usually in smaller groups at sandbars along the river (e.g., at the Lakeview sandbar). Recently 24 personal watercraft were counted at the Confluence launch site on one weekend day (Big Thicket staff, pers. comm. 2001), but it is unclear if this included multiple counts of the same craft.

PHOTO 7: PWC USER ON RIVER

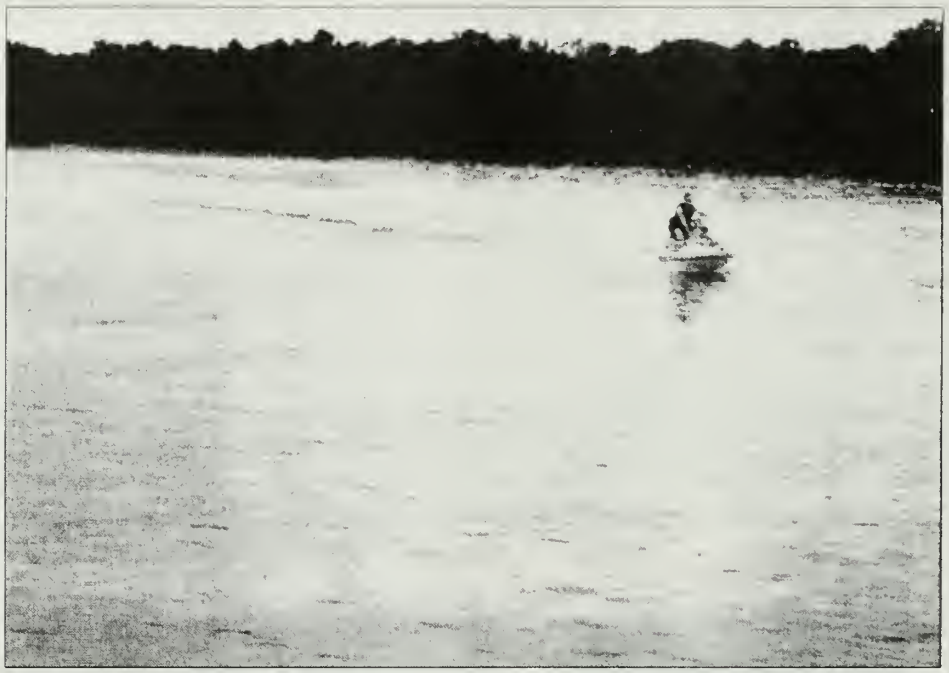


Table 5 summarizes the typical average use estimated for various use days over the year.

TABLE 5: ESTIMATED WATERCRAFT USE, BIG THICKET NATIONAL PRESERVE

	Days per Year	Larger "Sport" Boats and Pontoon Boats		Fishing Boats*		Personal Watercraft	
		Avg. No.	Hrs. Used	Avg. No.	Hrs. Used	Avg. No.	Hrs. Used
High Use Days — all summer weekends except holidays	26	46	6	15	4	12	4
Medium Use Days — remainder of summer days May through August	89	5	6	15	3	3	2
Low Use Days — all days in March, April, Sept., Oct., Nov.	150	3	3	10	3	.25	2
Very Low Use Days — all days in Dec., Jan., Feb.	90	0	0	5	2	0	0
No Use Days	10	0	0	0	0	0	0

Source: Big Thicket National Preserve staff (McHugh, pers. comm. 2001).

* About half larger than 50 hp, half smaller.

PWC use at Big Thicket most frequently occurs in the Neches River corridor near established campsites, launch areas, picnic grounds, docks/houses, or exposed sandbars (particularly Lakeview sandbar; see photo 8); PWC users often come in groups with only a limited number of personal watercraft and prefer to stay near the rest of the group located on the shore. This allows all the members of the group the opportunity to ride personal watercraft as well as recreate with their friends. Observations made by Big Thicket staff during May 2001 indicate that younger people predominantly use personal watercraft; however, there is also some PWC use by families and shoreline residents.

PHOTO 8: LAKEVIEW SANDBAR AREA

PWC users at Big Thicket are primarily local residents coming from within a roughly 20-mile radius. PWC users most often own their personal watercraft rather than rent them in part due to the limited number of rental businesses near Big Thicket. Four PWC distributors were interviewed in September 2001 regarding PWC use in the area. Two of the dealers said that PWC use has generally remained the same over the past five years, while the other two said that PWC use had decreased (Golden Triangle Cycle Center, Donalson Kawasaki, T&S Cycle, Kawasaki Country, pers. comm. 2001). Locals are the most common PWC consumer, and the majority of dealers stated that purchasing is more frequent than renting personal watercraft. In terms of locational trends, the dealers stated that PWC use most commonly occurs at local lakes, reservoirs, rivers, and the Gulf of Mexico. The majority of dealers also stated that two-stroke engines are the most common in the area, but that four-stroke engines are likely to be more prevalent in the future.

Staff at Big Thicket have received some complaints about PWC users, which include general rowdiness, noise, lack of consideration for fishermen and their lines, and choppy water (especially near the Collier's Ferry boat ramp) that makes it difficult for other watercraft to launch or dock.

National Preserve Visitation

Yearly visitation to the national preserve from 1978 to 2000 averaged approximately 65,000, but visitation generally increased during the period from 1987 to 1996 (NPS 2001c), and the average yearly visitation from 1990 to 2000 was 82,860 (Table 6). Since 1996, visitation has gradually decreased and appears to have leveled off. Visitation counts for each unit in the national preserve are unavailable at this time, therefore visitation in specific areas is largely based on visitor information station counts.

The majority of visitor use is regional. Yet the visitor registration log at the information station records annual visitation from all 50 states and at least 20 countries. It is likely that Big Thicket's biosphere reserve designation creates an international use pattern.

TABLE 6. ANNUAL VISITATION AT BIG THICKET NATIONAL PRESERVE

Year	Annual Visitation
1990	77,930
1991	64,076
1992	72,269
1993	82,854
1994	127,313
1995	115,466
1996	111,626
1997	77,633
1998	60,087
1999	60,193
2000	62,009
Average	**82,860**

SEASONAL USE PATTERNS

Watercraft use at Big Thicket, including personal watercraft, occurs most frequently during the summer on weekends. Holiday weekends at Big Thicket are not particularly crowded, because many watercraft users prefer sites outside the national preserve, such as Steinhagen Lake to the north. Watercraft use during the fall and winter is less common, mostly involving hunters traveling to areas inaccessible by foot or automobile.

Spring is the busiest visitor use period. Early spring travelers, mostly bird-watchers from a majority of states and several countries, converge on the general area. For several weeks in late spring school groups of up to 100 arrive daily to participate in educational programs at the national preserve. Weekend use increases as visitors from the region use trails and go fishing and boating.

Summer use is light because of high temperatures and humidity. Users are families from outside the region on traditional summer family vacations and visiting several attractions in a two- or three-week period. Local light visitation continues with fishing and boating activities.

Fall visitor use is moderate to high and consists of late seasonal travelers and school groups. Depending on weather conditions, regional visitor use can be high as people are enjoying outdoor recreation during cooler temperatures and humidities. Boating and fishing also occur during the fall months.

Winter use is light, with seasonal travelers consisting of retirees and some regional visitor use. During hunting season, from October through early January, up to 2,300 permits are issued for hunting in select units. Hunting limits other visitor uses, such as hiking, horseback riding, and off-road bicycling, due to safety issues and concerns. Boating and fishing are rare during the winter months.

VISITOR SAFETY

The 1980 *General Management Plan* for Big Thicket does not specify regulations or restrictions to watercraft use in the park; however, the National Park Service does enforce Texas regulations

pertaining to watercraft use (Texas water safety regulations can be found in title 4, chapter 31, subchapter A of the *Texas State Code;* Texas n.d.). Key regulations include the following:

- All personal watercraft must be registered.
- People born after 1984 must carry photo identification and a boater education certificate.
- People between the ages of 13 and 16 may operate a personal watercraft if they pass a boater education course.
- People younger than 16 cannot operate a PWC machine unless accompanied by an adult.
- A personal flotation device is mandatory.
- An automatic cutoff on the personal watercraft is required.
- No PWC operation is allowed from sunset to sunrise.
- No operation is allowed within 50 feet of another vessel, person, platform, object or shore unless at no-wake speed.
- The user must not operate the craft negligently, meaning awareness of other vessels, awareness of environmental concerns, and respecting the rights of shoreline property owners.
- No wake jumping is allowed.
- Users may not operate recklessly, meaning no excessive speed in regulated or congested areas, no operating in a manner that may cause an accident, no operating in a swimming area with bathers present, no operating in a manner that endangers life or property.
- Users may not operate under the influence of alcohol or drugs.
- All owners or operators must carry evidence of PWC insurance with them at all times.

An internal study by Big Thicket reports that from 1995 to 2000 there were 186 law enforcement actions involving watercraft in the preserve (NPS 2001c). Of these reported actions, a total of 52 involved personal watercraft and the remaining 134 were boat-related. Of the 52 PWC-related actions, 46 PWC users were issued citations and 6 were given warnings. The subject of these enforcement actions include creating a wake in a no-wake zone (28), not wearing a personal flotation device (8), not carrying a fire extinguisher (6), reckless driving (3), towing without lookout or mirror (2), driving under the influence of alcohol (1), being underage (1), having no registration (1), and operating within 50 feet of another watercraft (1).

There have been no reported fatalities or accidents involving personal watercraft, in part because personal watercraft are generally able to avoid collisions with unexpected obstacles if the driver is experienced and does not let up on the accelerator to the point at which steering is compromised. Also, personal watercraft can slow down relatively quickly in comparison to larger boats, which can continue forward for some distance even after the engine is shut down. Personal watercraft can also avoid submerged objects because they float higher than other watercraft.

CULTURAL RESOURCES

Cultural resources, including archeological sites, traditional Native American cultural properties, and historic sites, districts, buildings, and objects, are protected under section 106 of the National Historic Preservation Act of 1966, as amended.

No known cultural resources including any traditional cultural properties or sites listed on the National Register of Historic Places are known to occur along the lower Neches River corridor. A complete cultural resources inventory of this area has not been conducted. Cultural resources, including archeological and historic sites, are unlikely to occur along the lower Neches River corridor because floodplains are typically low probability areas for cultural resources due to the dynamics of the river exposing and washing away cultural remains. Isolated artifacts have been infrequently discovered in the cut-banks or along the shorelines of the lower Neches River, but these discoveries have rarely indicated the presence of additional buried, intact sites. Because a complete cultural resources inventory of the area has not been conducted, it is still possible that cultural resources may exist along the lower Neches River.

SOCIOECONOMIC ENVIRONMENT

A detailed description of the socioeconomic environment affected by PWC use at Big Thicket is provided in the report "Economic Analysis of Personal Watercraft Regulations in Big Thicket National Preserve" (Law Engineering and Environmental Sciences, Inc., et al. 2002).

Cities and towns in the vicinity of Big Thicket include Beaumont, Lufkin, Kountze, Silsbee, Woodville, Jasper, and Cleveland. These towns rely on tourism as an important part of their economies. However, PWC use in the preserve is not one of the primary forms of recreation in this area, especially for tourists. No PWC rental shops are located near Big Thicket. PWC use in the preserve is believed to be almost exclusively by PWC owners and dominated by local residents using their personal machines, although people from more distant areas who have a camp near Big Thicket may also use their machines in the preserve. In addition, alternative places for PWC recreation are nearby and are more popular destinations than Big Thicket because of their size and increased recreational opportunities. Also, many other leisure opportunities, such as boating, fishing, hiking, and bird watching, are available in the region.

While no PWC rental shops were identified in the immediate vicinity of the national preserve, three dealerships providing PWC sales and service were identified in the Beaumont area. In addition to personal watercraft, these establishments also rent and sell other equipment, such as all-terrain vehicles, motorcycles, and tractors. Even though year-to-year PWC sales appear to be quite variable, two of the three owners/operators indicated there has been a downward trend in PWC sales over the last few years. They attribute this trend to more vigorous enforcement of existing state and/or federal boating regulations. In other areas, PWC shop owners have indicated that they believe that the market for PWC sales is beginning to be saturated, and individuals tend to keep their watercraft for at least four or five years before upgrading to a new model.

Interviews with local PWC shops indicate that people who own camps along the Neches River frequently use their machines to recreate in the river as one of their daily activities while at their camp, although they may also trailer them to alternative areas for weekend trips. Other PWC users trailer their machines to the river and may spend some of their day on the river in Big Thicket and some of their day below the preserve boundary.

While PWC access between Steinhagen Lake and the national preserve is not possible because of a dam, watercraft users can access Big Thicket from Village Creek State Park just west of the Lower Neches River Corridor Unit. Other waterbodies in the general vicinity of Big Thicket that allow watercraft use include Rayburn Reservoir, Sabine Reservoir, Lake Livingston, Lake Houston, Toledo

Bend Reservoir, Keith Lake, Clam Lake, Gulf of Mexico, Galveston Bay, East Bay, and the southern extent of the Neches River.

In addition to businesses offering PWC sales and service, lodging establishments, restaurants, gas stations, and retail stores in the area could potentially be affected by changes in PWC use within the preserve. However, local businesses and park officials stated that almost all PWC users in this area are local. Thus, it is unlikely that businesses that focus on tourists from outside the region, such as lodging establishments or gift shops, would be affected by a change in park visitation by PWC users.

NATIONAL PRESERVE MANAGEMENT AND OPERATIONS

Currently 5.5 rangers are available at Big Thicket National Preserve for patrols and enforcement activities. Game wardens from the Texas Department of Parks and Wildlife enforce state regulations on boat activities and fishing. With regard to PWC use, only the launch site within the preserve at Beaumont is monitored. NPS staff have no control over the use of private launches along the lower Neches River. If state or NPS regulations are violated, warnings are given first, followed by citations (see page 61 for the types of citations issued over the last five years) at the discretion of the rangers based upon each case. Case incidents relating to PWC use violations are entered into a database.

ENVIRONMENTAL CONSEQUENCES

SUMMARY OF LAWS AND POLICIES

Three overarching environmental protection laws and policies guide the National Park Service — the National Environmental Policy Act of 1969, and its implementing regulations: the National Parks Omnibus Management Act of 1998 (NPOMA); and the NPS Organic Act.

1. The National Environmental Policy Act is implemented through regulations of the Council on Environmental Quality (40 CFR 1500–1508). The National Park Service has in turn adopted procedures to comply with NEPA and the CEQ regulations, as found in *Director's Order #12: Conservation Planning, Environmental Impact Analysis, and Decision-making* (2001), and its accompanying handbook.

2. The National Parks Omnibus Management Act of 1998 (NPOMA) (16 USC 5901 et seq.) underscores the National Environmental Policy Act in that both are fundamental to NPS park management decisions. Both acts provide direction for articulating and connecting the ultimate resource management decision to the analysis of impacts, using appropriate technical and scientific information. Both also recognize that such data may not be readily available, and they provide options for resource impact analysis should this be the case.

   NPOMA directs the National Park Service to obtain scientific and technical information for analysis. The NPS *Director's Order #12 Handbook* states that if "such information cannot be obtained due to excessive cost or technical impossibility, the proposed alternative for decision will be modified to eliminate the action causing the unknown or uncertain impact or other alternatives will be selected" (*DO #12 Handbook*, sec. 4.4).

   Section 4.5 of *Director's Order #12* adds to this guidance by stating "when it is not possible to modify alternatives to eliminate an activity with unknown or uncertain potential impacts, and such information is essential to making a well-reasoned decision, the NPS will follow the provisions of the regulations of CEQ (40 CFR 1502.22)." In summary, the Park Service must state in an environmental assessment or impact statement (1) whether such information is incomplete or unavailable; (2) the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment; (3) a summary of existing credible scientific adverse impacts which is relevant to evaluating the reasonably foreseeable significant adverse impacts; and (4) an evaluation of such impacts based on theoretical approaches or research methods generally accepted in the scientific community.

3. The 1916 Organic Act (16 USC 1) commits the Park Service to making informed decisions that perpetuate the conservation and protection of park resources unimpaired for the benefit and enjoyment of future generations.

GENERAL METHODOLOGY FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS

While much has been observed and documented about the overall effects of personal watercraft on the environment, as well as public safety concerns, the site-specific impacts, or impacts on any particular resource, under all conditions and scenarios are more difficult to measure and affirm with absolute confidence. Even with monitoring, data collected and interpreted since personal watercraft were introduced in parks, and their effects on park resources relative to other uses and influences, are difficult to define and quantitatively measure.

Recognizing this dilemma, the interdisciplinary planning team created a process for impact assessment, based on the directives of the *Director's Order #12 Handbook* (sec. 4.5(g)). National park system units are directed to assess the extent of impacts to park resources as defined by the context, duration, and intensity of the effect. While measurement by quantitative means is useful, it is even more crucial for the public and decision-makers to understand the implications of those impacts in the short and long term, cumulatively, and within context, based on an understanding and interpretation by resource professionals and specialists. With interpretation, one can ascertain whether a certain impact intensity to a park resource is "minor" compared to "major" and what criteria were used to draw that conclusion.

To determine impacts, methodologies were identified to measure the change in park resources that would occur with the implementation of the PWC management alternatives. Thresholds were established for each impact topic to help understand the severity and magnitude of changes in resource conditions, both adverse and beneficial, of the various management alternatives.

Each PWC management alternative is compared to a baseline to determine the context, duration, and intensity of resource impacts. The baseline, for purposes of impact analysis, is the continuation of PWC use and current management projected over the next 10 years (alternative A).

In the absence of quantitative data, impacts were assessed qualitatively based on best professional judgment. In general, the thresholds used come from existing literature on personal watercraft, federal and state standards, and consultation with subject matter experts and appropriate agencies.

In addition to establishing impact thresholds, the park's resource management objectives and goals (as stated in chapter 1) were integrated into the impact analysis. In order to further define resource protection goals relative to PWC management, the park's *Strategic Plan* was used to ascertain the "desired future condition" of resources over the long term. The impact analysis then considers whether each PWC management alternative contributes substantially to the park's achievement of its resource goals, or would be an obstacle to achieving the resource goal as defined by the *Strategic Plan*. The planning team then considered potential ways to mitigate effects of personal watercraft on park resources, and modified the alternatives accordingly.

For the purposes of analysis, the following assumptions are used for all impact topics:

Short-term impacts: Those occurring from PWC use in the immediate future (per trip through a single season of use, usually 1 to 6 months).

Long-term impacts: Those occurring from PWC use over several seasons of use through the next 10 years (2002 to 2012).

Direct impacts: Those occurring from the direct use or influence of personal watercraft.

Indirect impacts: Those occurring from PWC use that have indirectly altered a resource or condition.

Cumulative impacts: Those occurring from continued PWC use at the park, when considered in context with other site-specific, local, or regional past, present, and reasonably foreseeable actions/activities that could affect the same resources or conditions, both inside and outside park boundaries.

Study area: Each resource impact is assessed in direct relationship to those resources affected both inside and outside the park, to the extent that the impacts can be substantially traced, linked, or connected to PWC use inside park boundaries. Each impact topic, therefore, has a study area relative to the resource being assessed, and it is further defined in the impact methodology.

Unless otherwise noted in the impact analysis, impacts would be adverse.

Impairment Analysis

The National Park Service is prohibited from impairing park resources and values by the NPS Organic Act. The NPS *Management Policies 2001* (sec. 1.4.5) state "an impairment . . . is an impact that, in the professional judgment of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values." In addition, the *Management Policies* state "whether an impact meets this definition depends on the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts."

The *Management Policies* also state, "an impact to any park resource or value may constitute an impairment . . . to the extent that it affects a resource or value whose conservation is . . . necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park; key to the natural or cultural integrity of the park or to opportunities for enjoyment of the park; or identified as a goal in the park's general management plan or other relevant NPS planning documents."

The determination of impairment is closely tied to the outcome of the resource impact analysis. This determination is also made with a parallel consideration of the park's legislative mandates (purpose and significance), and resource management objectives as defined in its general management plan or other relevant plans.

The following process was used to determine whether the various PWC management alternatives had the potential to impair park resources and values:

1. The park's enabling legislation, *General Management Plan, Strategic Plan,* and other relevant background was reviewed to ascertain the park's purpose and significance, resource values, and resource management goals or desired future conditions.
2. PWC management objectives specific to resource protection goals at the park were identified.
3. Thresholds were established for each resource of concern to determine the context, intensity and duration of impacts, as defined above.
4. An analysis was conducted to determine if the magnitude of impact reached the level of "impairment," as defined by NPS *Management Policies.*

The impact analysis includes any findings of impairment to park resources and values for each of the management alternatives.

PWC and Other Watercraft Use Trends

Big Thicket does not have specific boat or PWC launch data that can be apportioned within the overall park visitation numbers. Therefore, personal watercraft use trends were estimated based on the preserve staff's observations and estimates, along with opinions obtained from PWC dealers in the area (McHugh, pers. comm. 2001: Golden Triangle Cycle Center, Donalson Kawasaki, T&S Cycle, Kawasaki Country, pers. comm. 2001). These trends are discussed in the "Visitor Use and Experience" section of the "Affected Environment" (see page 57). Some dealers indicated that PWC use would increase slightly, while others felt it would stay the same or even decline. Preserve staff who frequently patrol the river and who even use it personally for recreation believe that, unlike national trends, PWC use has flattened out and will probably remain at about current levels over the next few years. This is in accordance with overall park visitation trends for the past several years. A similar trend was assumed for overall boating use, including fishing and sport boating, since the leveling off of visitation seems to apply to all uses, and there are no data to support any other conclusion. Therefore, considering all the opinions of the informed sources consulted, it was assumed that PWC and boat use would likely continue at about current levels for the period of analysis used in this environmental assessment.

WATER QUALITY

Most research on the effects of personal watercraft on water quality focuses on the impacts of two-stroke engines, and it is assumed that any impacts caused by these engines also apply to the personal watercraft powered by them. There is general agreement that two-stroke engines (and personal watercraft) discharge a gas-oil mixture into the water. Fuel used in PWC engines contains many hydrocarbons, including benzene, toluene, ethylbenzene, and xylene (collectively referred to as BTEX). Polycyclic aromatic hydrocarbons (PAHs) also are released from boat engines, including those in personal watercraft. These compounds are not found appreciably in the unburned fuel mixture, but rather are products of combustion. Discharges of all these compounds — BTEX and PAHs — have potential adverse effects on water quality. (A common gasoline additive, methyl tertiary butyl ether (MTBE) is not used in Texas.)

A typical conventional (i.e., carbureted) two-stroke PWC engine discharges as much as 30% of the unburned fuel mixture into the exhaust (California Air Resources Board 1999). At common fuel consumption rates, an average two-hour ride on a personal watercraft may discharge 3 gallons (11.34 liters) of fuel into the water (NPS, VanMouwerik and Hagemann, 1999). The Bluewater Network states that personal watercraft can discharge between 3 and 4 gallons of fuel over the same time period.

Guiding Regulations and Policies

The U.S. Environmental Protection Agency has developed national recommended ambient water quality criteria for approximately 120 priority pollutants for the protection of both aquatic life and human health (through ingestion of fish/shellfish or water) (US EPA 1998). These criteria have been adopted as enforceable standards by most states. The Environmental Protection Agency has not established any criteria for the protection of aquatic life for any of the PWC-related compounds stated

above. For the human health criteria, however, the Environmental Protection Agency has established criteria for benzene, ethylbenzene, toluene, and several PAH compounds. There are no criteria for xylene.

The NPS *Management Policies 2001* state that the Park Service will "take all necessary actions to maintain or restore the quality of surface waters and ground waters within the parks consistent with the Clean Water Act and all other applicable federal, state, and local laws and regulations" (sec. 4.6.3).

At Big Thicket, personal watercraft are permitted in only a small portion of the preserve, in the lower Neches River and the mouth of Pine Island Bayou. Texas has designated these waters as "water-quality-limited." This means that they do not meet all of their designated uses. The Texas Natural Resources Conservation Commission is responsible for water quality in the state, and it administers provisions of the Clean Water Act under the supervision of the Environmental Protection Agency.

In view of the absence of water quality criteria or standards to protect aquatic life, the Texas Natural Resource Conservation Commission states that "appropriate chronic toxicity data" can be used (TNRCC Title 30, Part 1, Ch. 307.6). Therefore, chronic benchmarks were selected from U.S. Fish and Wildlife Service (USFWS 2000) and Suter and Tsao (1996) for use in evaluating impacts to water quality from PWC use in Big Thicket. The selected benchmarks for benzo(a)pyrene and benzene are the same as those used by the commission in conducting ecological risk assessments (TNRCC 2001b). Human health (fish and water ingestion) water quality criteria for benzo(a)pyrene and benzene were taken from EPA water quality criteria (US EPA 1999a).

Simply stated, a water quality standard defines the water quality goals for a waterbody by designating uses to be made of the water, by setting minimum criteria to protect the uses, and by preventing degradation of water quality through antidegradation provisions. The antidegradation policy is only one portion of a water quality standard. Part of the Clean Water Act policy (40 CFR 131.12(a)(2)) strives to maintain water quality at existing levels if it is already better than the minimum criteria necessary to protect the uses. Antidegradation should not be interpreted to mean that "no degradation" can or will occur, as even in the most pristine waters, degradation may be allowed for certain pollutants as long as it is temporary and short-term in nature (Rosenlieb, pers. comm., 2001).

Methodology and Assumptions

In order to assess the magnitude of water quality impacts to park waters under the various PWC management alternatives, the following methods and assumptions were used:

1. The regulation in 40 CFR 131.12(a)(2), the anti-degradation policy, represents an overall goal or principle with regard to PWC use in that the park unit will strive to fully protect existing water quality so that "fishable/swimmable" uses and other existing or designated uses are maintained. Therefore, PWC use could not be authorized to the degree that it would lower this standard and affect these uses. To do so would potentially violate 40 CFR 131.10, which basically forbids the removal of an existing use because an activity (e.g., personal watercraft) was authorized knowing this activity would cause an unacceptable level of pollution.
2. State water quality standards governing the waters of the park unit were examined; where standards or water quality criteria were not available for pollutants present in PWC emissions, chronic toxicity benchmarks for these pollutants were acquired from various literature sources. The classification of park waters by the state was defined; also, the overall sources of water pollutants, both internal and external to park boundaries, were identified in relation to the standards and classification.

3. Baseline water quality data, especially for pollutants associated with two-stroke engines (PAHs, BTEX), were sought but were not available for Big Thicket.

4. Typical use patterns of motorized watercraft, including numbers and hours used, were estimated from preserve visitation records and seasonal observations by NPS staff. For Big Thicket, the worst case scenario used for analysis was a high-use weekend day in the summer (June-August). This scenario includes an estimated average use of 12 personal watercraft on the river (based on preserve staff observations of high-use days). It was assumed these PWC users would be in the vicinity of the river for 6 to 8 hours, during which time each PWC machine would be operated for about 4 hours time total at full throttle (allowing for lunch/beach time). Typical worst-case boat use on the main channel of the Neches was assumed to be 46 larger sport and pontoon boats for 6 hours each, and 15 fishing boats for 4 hours each (8 of which were less than 50 hp). Other assumptions were made about probable use in backwater areas, which are provided in the analysis where they are used.

5. Since no models were available to predict concentrations in water of selected pollutants emitted by personal watercraft and motorboats, an approach was developed to estimate whether typical PWC (and outboard motor) use over a certain time (say, over a typical busy weekend day) would exceed the identified standards, criteria, or toxicity benchmarks. A worst case (high-use) scenario was used to compare with the benchmarks. Details of the approach are described in a separate document (appendix C). Results of this approach were then examined, along with site-specific information about water flow, currents, mixing, wind, turbidity, as well as the specific fate and transport characteristics of the pollutant involved (e.g. volatility), to assess the potential for the occurrence of adverse water quality impacts.

6. In general, the approach to estimating impacts provides the information needed to calculate emissions of selected hydrocarbons from personal watercraft (and from outboard motors) to the receiving waterbody. Hydrocarbons with known concentrations in the raw gasoline and for which ecological and/or human health toxicity benchmarks could be acquired from the literature were used in the assessments. The selected chemicals were benzene and three PAHs (benzo(a)pyrene, naphthalene, and 1-methyl naphthalene). The approach describes the procedure to estimate the total loading of the pollutants into the water based on the estimated hours of use (see appendix C). Then, the approach provides an estimate of how much water it would take to dilute the calculated emission loading to the water quality standard or benchmark concentration. That volume of water (referred to as the "threshold volume of water") is then compared with the total available volume of water within the selected study area.

7. The principal mechanisms that result in loss of the pollutant from the water also were qualitatively considered. Many organic pollutants that are initially dissolved in the water volatilize to the atmosphere, especially if they have high vapor pressures, are lighter than water, and mixing occurs at the air/water interface. Other compounds that have low vapor pressure, low solubility, and high octanol/water partition coefficients tend to adhere to organic material and clays and eventually adsorb onto river sediments. By considering movements of the organics through the water column, an assessment can be made as to whether there could be an issue with standards or benchmarks being exceeded, even on a short-term basis. Table 7 shows the standards and benchmarks used to assess impacts.

TABLE 7: ECOLOGICAL AND HUMAN HEALTH BENCHMARKS FOR ORGANIC POLLUTANTS

Chemical	Ecological Benchmark (µg/L)	Source	Human Health Benchmark** (µg/L)	Source
Benzo(a)pyrene	0.014	Suter and Tsao 1996	0.0044	US EPA 1999a**
Naphthalene	62	Suter and Tsao 1996	--	--
1-methyl naphthalene	19-34*	USFWS 2000	--	--
Benzene	130	Suter and Tsao 1996	1.2	US EPA 1999a**

* Based on LC_{50}s of 1900 and 3400 µg/L for dungeness crab and sheepshead minnow, respectively (34 µg/L used for freshwater calculations).
** Based on the consumption of water and fish.

8. The threshold volume of water was calculated in acre-feet (1 acre-foot = 1 acre of water 1 foot deep) for each hydrocarbon evaluated. For example, if results showed that for benzo(a)pyrene, 66 acre-feet of water were needed to dilute the expected emissions to below the benchmark level, and the receiving body of water is a 100-acre reservoir with an average depth of 20 feet (2,000 ac-ft), then this would indicate little chance of a problem, especially when adding the effects of any other processes that contribute to the loss of the benzo(a)pyrene from the water column. However, if the impact area is a 5-acre backwater that averages 2 feet deep (10 ac-ft), there could be a short-term impact, especially when adding outboard emissions.

9. To assess cumulative impacts, outboard emissions also were estimated, based on estimates of relative emissions of unburned fuel and hours of use. Then, motorboat emissions were added to PWC emissions to get a more complete estimation of cumulative loading to the receiving waterbody. Inboards are expected to contribute little to the loading and were not included in the estimation. The figures used for relative loading from personal watercraft and various outboard engines are estimates obtained from available reported data. Projections of existing use were extrapolated into the future based on the professional judgment of the Big Thicket staff and recent visitation trends to the preserve.

10. Reductions in emissions from personal watercraft and outboards required by the U.S. Environmental Protection Agency over the next 10 years are shown in Table 8.

TABLE 8: ESTIMATED EPA REDUCTIONS IN WATERCRAFT EMISSIONS

Date	Action
1999	US EPA requires production line testing for 75% HC reduction in new outboards and begins to see reductions as newer models are introduced (US EPA 1997).
2000	US EPA requires production line testing for 75% HC reduction in new personal watercraft and begins to see reductions as newer models are introduced (US EPA 1997).
2005	Estimated 25% reduction in HC emissions overall as a result of newer models being gradually used (US EPA 1996a; date modified in US EPA 1997).
2006	US EPA fully implements 75% HC reduction in new outboards and personal watercraft (US EPA 1996a).
2012	Estimated 50% reduction in HC emissions overall (US EPA 1996a; date modified in US EPA 1997)

Key dates in this chronology begin with 1999, when the U.S. Environmental Protection Agency began to require production line testing for 75% HC reduction in new outboard motors, and 2000, when testing for 75% HC reduction in personal watercraft was required. By 2006 all new personal watercraft and outboards manufactured in the United States must have a 75% reduction in HC emissions. In 2005 and 2012, overall reductions in HC emissions are estimated to be 25% and 50%, respectively, in personal watercraft and outboard motors. These estimates are based on interpolations of the emissions reduction percentages and associated years reported by the Environmental Protection Agency (1996a), but with a one-year delay in the implementation of production line testing (US EPA 1997). The 50% reduction estimated for 2012 was used in the calculation for this assessment.

Study Area

The study area includes surface waters in the lower Neches River and the mouth of Pine Island Bayou, where PWC use is allowed.

Impact to Water Quality from PWC Use

Given the above water quality impact estimation methodology and assumptions, the following impact thresholds were established in order to describe the impacts to water quality (both overall, localized, short and long term, cumulatively, adverse and beneficial), under the various PWC management alternatives.

Negligible: Impacts are chemical, physical, or biological effects that would not be detectable, would be well below water quality standards or criteria, and would be within historical or desired water quality conditions.

Minor: Impacts (chemical, physical, or biological effects) would be detectable but would be well below water quality standards or criteria and within historical or desired water quality conditions.

Moderate: Impacts (chemical, physical, or biological effects) would be detectable but would be at or below water quality standards or criteria; however, historical baseline or desired water quality conditions would be altered on a short-term basis.

Major: Impacts (chemical, physical, or biological effects) would be detectable and would be frequently altered from the historical baseline or desired water quality conditions; and/or chemical, physical, or biological water quality standards or criteria would be slightly and singularly exceeded on a short-term basis.

Impairment: Impacts are chemical, physical, or biological effects that would be detectable and that would be substantially and frequently altered from the historical baseline or desired water quality conditions and/or water quality standards, or criteria would be exceeded several times on a short-term and temporary basis. In addition, these adverse, major impacts to park resources and values would

contribute to deterioration of the park's water quality and aquatic resources to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. Alternative A would continue the current conditions at Big Thicket, which include PWC use in a restricted area of the lower Neches River and the mouth of Pine Island Bayou. Emissions to water from personal watercraft using this area consist of (1) unburned fuel that escapes through the exhaust valve during two-stroke operation, and (2) combustion products in gaseous exhaust. All emissions are usually exhausted below the water line, where the pollutants can escape to the atmosphere, dissolve in the water column, or become adsorbed to sediments suspended in the water column. Possible bio-

accumulation of contaminants that adhere to sediments are not discussed here, but are included in the discussion under "Wildlife and Wildlife Habitat."

Neches River / Pine Island Bayou — Under the assumed high-use scenario (12 personal watercraft on the river for 4 hours, or 48 PWC-hours), the following threshold volumes of water were calculated for 2002 and 2012. These are the minimum amounts of water needed to dilute the released contaminants to the levels of identified water quality standards, criteria, or toxicity benchmarks for selected PAHs and benzene (no MTBE is used in Texas).

The volume of the Neches River within the study area is estimated to be 6,030 acre-feet, based on a length of 55,000 feet, an average width of 300 feet, and an average depth of 16 feet; this takes into consideration sloping side margins (McHugh, pers. comm. 2001). This section of the Neches River is well mixed, with wind disturbance and river currents providing surface aeration and dilution. Contaminants released from 12 personal watercraft in one area would be diluted with incoming upstream water and moved downstream, with the amount of dilution dependent on water volume and flow conditions at the time. Even under low flow, substantial dilution would occur. During the period of June through August, the median daily flows in the river range from 1,200 to 3,500 cubic feet per second (cfs) (see the figures on page 37), with an average of near 2,400 cfs. Under average flow conditions June through August, the average water velocity through the river is estimated to be 0.5 feet/second. At this rate a parcel of water would move the entire length of the Neches River (55,000 feet) in approximately 1.25 days. Faster flows would be expected during releases from upstream dams.

In 2002 the static volume of the river (6,030 ac-ft) is well above the threshold volumes for all organics except benzene, based on human health benchmarks (6,800 ac-ft). The threshold volumes for all other PWC-related organics evaluated are at least an order of magnitude less than the volume of the river, even without considering dilution or other removal mechanisms. Therefore, for all compounds except benzene, impacts would be considered negligible (see Table 9).

TABLE 9: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC EMISSIONS IN THE NECHES RIVER, ALTERNATIVE A

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	66	33	210	105
Naphthalene	26	13	N/C	N/C
1-methyl Naphthalene	75	38	N/C	N/C
Benzene	63	32	6,800	3,400

Note: Estimated static volume of river in study area = 6,030 acre-feet.

N/C – No criteria or benchmark.

For benzene, other factors affecting surface water concentrations (especially volatilization) must be considered. The half-life of benzene in water is less than 5 hours at summer water temperatures near 30°C (Verschuren 1983; US EPA 2001). In other words, half the benzene in water would evaporate in less than 5 hours, and only one-fourth the benzene would remain after less than 10 hours. Given that most benzene volatilizes over a relatively short time and the threshold volume is virtually the same as the static river volume, it is highly unlikely that the human health water quality benchmark would be approached in the river. Even if some of the benzene remained in the water and was "carried over" to a following day of high use (e.g., from Saturday to Sunday), the amount of water available plus the other removal processes operating in the water (e.g., volatilization, dilution from upstream water replacement, oxidation, biodegradation, adsorption) indicate that the benchmark would not be exceeded. Therefore, water quality impacts from PWC-related benzene in the Neches River in 2002 would be negligible to minor.

By 2012 emissions of hydrocarbons from personal watercraft are expected to be half of current levels because of the introduction of less-polluting engines (US EPA 1996a, 1997). The threshold volumes calculated for all the hydrocarbons assessed are shown in Table 9, assuming that PWC use at Big Thicket remains constant over the next 10 years. The threshold volume for benzene based on the human health benchmark would be 3,400 acre-feet, which is below the static volume of the river in that area (6,030 ac-ft). Therefore, the human health water quality benchmark for benzene (and the evaluated PAHs) would not be approached in 2012 due to PWC use of the Neches River, and water quality impacts from PWC-related organics (PAHs and benzene) in 2012 would be negligible to minor.

Backwater Areas — In addition to assessing the main channel of the Neches River, backwater areas were examined separately, since these areas would most likely be affected in the short term by high PWC use. Based on preserve staff observations, few PWC users venture into these areas because of low overhanging vegetation, shallow and silty water, snags at shallow depths, and no room for performing stunts or going fast. However, because PWC use does occasionally occur in these areas, an analysis was conducted. The scenario assumed for the purpose of the analysis was one (1) PWC entering a backwater area and staying there for a maximum of one-half hour (0.5 PWC-hour). Table 10 shows the threshold volumes of water that would be needed to reduce contaminant concentrations to below the standard levels for both the 2002 and 2012 timeframes.

TABLE 10: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC EMISSIONS IN BACKWATER AREAS, ALTERNATIVE A

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	0.69	0.35	2.2	1.1
Naphthalene	0.27	0.14	N/C	N/C
1-methyl Naphthalene	0.78	0.39	N/C	N/C
Benzene	0.66	0.33	71	35

Note: Estimated "typical" backwater area = 48 acre-feet
N/C – No criteria or benchmark.

A typical backwater oxbow lake area will have a much reduced water volume compared to the main river channel. A backwater volume estimate of 48 acre-feet was used, based on an area of 12 acres and an average depth of 4 feet (McHugh, pers. comm. 2001).

For 2002 a direct comparison of threshold volumes with the backwater volume estimate suggests that benzene concentrations could exceed the human health benchmark or at least be a short-term problem in these backwater areas, based on a comparison with human health benchmarks. Based on a half-life of less than 5 hours for benzene in water, benzene concentrations would be less than the human health benchmark in less than 5 hours. However, in backwater areas there would be less mixing and dilution than in the main river channel, such that a residual concentration of benzene greater than the human health benchmark could occur for a short period of time. Therefore, using these assumptions impacts in backwater areas from PWC-related releases of benzene would be moderate to potentially major.

For 2012 Table 10 shows that the threshold volumes for all compounds assessed would be one-half the values shown for 2002, assuming that PWC emissions of hydrocarbons would be half current emissions. The threshold volume for benzene (35 ac-ft) would be less than that of a typical backwater area (48 ac-ft), and impacts are considered minor. Impacts from PAHs and from benzene compared with its ecological benchmark are considered minor.

Regarding potential concentrations of contaminants near drinking water intakes, intakes are not in areas where personal watercraft congregate, and there would be no reason to suspect that benzene or other relatively volatile pollutants in gasoline would approach drinking water standards for human health in this area. The city of Beaumont does not test its intake water, but its treated water has passed all required tests for any contaminants related to gasoline or oil contamination.

Cumulative Impacts. *Neches River / Pine Island Bayou* — For the cumulative impact evaluation, other sources of PAHs and benzene such as other boats, oil and gas leakage (e.g., from instream abandoned wells, nonpoint runoff of PAHs and oils, and aerial disposal of PAHs) are considered. The largest contribution would likely come from other motorized boats using the river. Therefore, emissions from these boats were quantitatively evaluated. The following typical high-use scenario is based on information provided by preserve staff:

> A total of 46 large sport boats use the river each day for 6 hours each.
>
> A total of 15 boats are used for fishing — 8 small boats for 4 hours each, and 7 large boats for 4 hours each.

For the purpose of estimating emissions from boats, it was assumed that large boats discharge PAHs and benzene at a rate equal to personal watercraft, and that small boats discharge organics at a rate twice that of personal watercraft.

Because of the relatively large number of boats using the river compared to personal watercraft, discharge of hydrocarbons from the boats is substantially greater than from personal watercraft. Table 11 shows the estimated threshold volumes for the Neches River in 2002 and 2012, based on the cumulative emissions from 12 personal watercraft, 46 sport boats, 8 small fishing boats, and 7 large fishing boats.

TABLE 11: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC AND MOTORIZED BOAT EMISSIONS IN THE NECHES RIVER, ALTERNATIVE A

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	570	285	1,800	900
Naphthalene	230	115	N/C	N/C
1-methyl Naphthalene	650	325	N/C	N/C
Benzene	540	270	59,000	29,500

Note: Estimated static volume of river in study area = 6,030 acre-feet.

N/C – No criteria or benchmark.

In 2002, based on these threshold volumes for personal watercraft and boats, impacts would be negligible for all the compounds except benzene, based on the human health benchmark. The human health-based threshold volume (59,000 ac-ft) for benzene is considerably greater than the static volume of the river (6,030 ac-ft). Based on an estimated half-life of less than 5 hours for benzene, benzene concentrations in the river due to personal watercraft and boats are expected to be lower than the human health benchmark in less than 20 hours. Although other mechanisms such as oxidation and biodegradation would also operate to reduce benzene concentrations in the water, it is not possible to say whether or not the benchmark would be exceeded on a short-term basis during summer high use periods, especially during periods of low flow. Therefore, cumulative human-health based impacts to water quality in the river from emissions of benzene could be major in 2002, based on the estimations performed for this assessment. The incremental impact of PWC use on the river would be minor. Results from some studies conducted in areas of high PWC use have shown concentrations of benzene exceeding 1.0 µg/L (Allen et al. 1998), so a prediction of concentrations exceeding 1.2 µg/L is not

unreasonable. However, since this assessment is based solely on an estimation and not a verified model, water quality monitoring would need to be done to confirm this result.

In 2012 emissions from personal watercraft and motorized boats on the river are expected to be 50% of current levels in response to the introduction of four-stroke and less-polluting two-stroke engines, as shown in Table 11. The human health related threshold volume for benzene (29,500 ac-ft) would be the only threshold volume greater than the river volume; all other volumes would be substantially lower than the river volume. Consequently, water quality impacts from PAHs would be negligible. Based on the 5-hour estimated half-life for benzene, concentrations in the river in 2012 are expected to be lower than the human health benchmark in less than 15 hours, and other removal mechanisms would serve to reduce levels further. Therefore, impacts related to human health from benzene from all PWC and boats on the river are considered moderate in 2012.

Backwater Areas — As previously discussed, backwater areas would most likely be impacted by emissions from both personal watercraft and boats. For the cumulative analysis, it was assumed that one small boat would be in the backwater area for two hours each day. Table 12 shows the threshold volumes needed in 2002 and 2012 to reduce contaminant emissions from personal watercraft and motorized boats to below benchmark levels under alternative A.

TABLE 12: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC AND MOTORIZED BOAT EMISSIONS IN BACKWATER AREAS, ALTERNATIVE A

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	3.4	1.7	11	5.5
Naphthalene	1.4	0.7	N/C	N/C
1-methyl Naphthalene	3.3	2.0	N/C	N/C
Benzene	3.3	1.7	350	180

Note: Estimated "typical" backwater area = 48 acre-feet

N/C – No criteria or benchmark.

For 2002 a comparison of these threshold volumes with the estimated backwater volume (48 ac-ft) indicates that benzene concentrations would exceed human health benchmarks. Impacts to aquatic biota from PAHs and benzene, and impacts to human health from all hydrocarbons except benzene, would be negligible, given that threshold volumes are less than the typical backwater volume and that removal processes would also reduce concentrations of these hydrocarbons. While PWC incremental impacts would be minor, cumulative impacts to human health from benzene from personal watercraft and motorized boats are considered moderate to potentially major. This is because the threshold volume (350 ac-ft) is substantially greater than the assumed backwater volume of 48 acre-feet. It would take less than 15 hours for the concentration of benzene in backwater areas to become lower than the human health benchmark. Also, backwater areas would not have the flushing associated with the main river currents to help dilute benzene in the water column. Monitoring would be required to confirm these results.

In 2012 the emission rates from personal watercraft and fishing boats would be half of the emissions in 2002, and the required threshold volumes are shown in Table 12. Again, impacts to aquatic biota from PAHs and benzene and to human health from benzo(a)pyrene are expected to be negligible when compared to the volume of the backwater (48 ac-ft). For benzene, the threshold volume (180 ac-ft) is greater than the backwater volume. However, after only about 10 hours, concentrations of benzene in the backwater area would be lower than the human health benchmark, considering other removal mechanisms along with this volatilization. Therefore, while PWC incremental impacts would be

minor, cumulative impacts from all boats to human health from benzene are expected to be moderate in backwaters in 2012.

Conclusion. Under alternative A impacts from PWC-related PAHs selected for analysis and benzene in the main river would be negligible to minor in both 2002 and 2012. In backwater areas in 2002 impacts from benzene could be moderate to potentially major based on human health benchmarks (because there is much less water volume and also less mixing or dilution), and minor based on ecological benchmarks. In 2012, assuming that the emissions of hydrocarbons from newer engines are half that of older models, impacts from all hydrocarbons to water quality in backwater areas would be negligible to minor, based on both human health and ecological benchmarks.

Under the cumulative evaluation for personal watercraft and motorized boats to water quality in the river, in 2002 impacts would be negligible for all the compounds except benzene, based on the human health benchmark. Cumulative human-health based impacts to water quality in the river from emissions of benzene from boats could be moderate to potentially major in 2002, based on the estimations performed for this assessment. The incremental impact of PWC use on the river would be minor. Cumulative impacts would be reduced to a moderate impact in 2012 because it is expected that more four-stroke engines would be used, in accordance with the EPA requirements. In backwater areas, impacts from benzene would be moderate and possibly major in 2002 and moderate in 2012. PWC contribution to these cumulative impacts would be negligible to minor.

Alternative A would not result in impairment to water quality.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. *Neches River / Pine Island Bayou* — Under alternative B emissions and impacts from personal watercraft in the main channel of the Neches River would be similar to those described for alternative A. For all organics evaluated except benzene, impacts would be negligible to minor. Impacts from PWC-related benzene in the river (based on human health impacts) would be negligible to minor, considering the dilution and volatilization that would occur. By 2012 it is estimated that PWC emissions would be reduced to 10% of current emissions because of the provision in alternative B that would require four-stroke engines to be phased in more rapidly than required by the Environmental Protection Agency. Table 13 shows the estimated threshold volumes under alternative B for the Neches River. As shown for 2012, the benzene threshold volume (680 ac-ft) would be approximately one-tenth of the volume of the river, and water quality impacts related to PWC emissions of benzene would be negligible. Impacts to aquatic biota and humans from all other hydrocarbons would also be negligible.

TABLE 13: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC EMISSIONS IN THE NECHES RIVER, ALTERNATIVE B

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	66	6.6	210	21
Naphthalene	26	2.6	N/C	N/C
1-methyl Naphthalene	75	7.5	N/C	N/C
Benzene	63	6.3	6,800	680

Note: Estimated static volume of river in study area = 6,030 acre-feet

N/C – No criteria or benchmark.

Backwater Areas — Under alternative B prohibiting PWC use in backwater areas would eliminate impacts to water quality in those areas.

Cumulative Impacts. *Neches River* — Under the cumulative evaluation for personal watercraft and motorized boats for alternative B in the Neches River, impacts would be similar to alternative A. Under alternative B, upon implementation of a PWC special regulation, PWC emissions would gradually decrease with the phasing in of four-stroke engines; therefore, impacts would be reduced from those described in alternative A. By 2012 required threshold volumes to dilute pollutants would be reduced from those under alternative A because PWC emissions are expected to be 10% of current emissions based on the phase-in of four-stroke engines. Other boat emissions would be reduced the same as estimated for alternative A, based on the EPA requirements. Table 14 shows predicted threshold volumes for the Neches River channel.

TABLE 14: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC AND MOTORIZED BOAT EMISSIONS IN THE NECHES RIVER, ALTERNATIVE B

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	570	260	1,800	820
Naphthalene	230	100	N/C	N/C
1-methyl Naphthalene	650	300	N/C	N/C
Benzene	540	250	59,000	27,000

Note: Estimated static volume of river in study area = 6,030 acre-feet.

N/C – No criteria or benchmark.

Since so few personal watercraft are used relative to motorized boats, the 90% reduction in PWC emissions would not appreciably change overall water quality in the Neches River and Pine Island Bayou, however, the phasing in of cleaner four-stroke PWC engines is consistent with the park's mission goal to preserve park resources (NPS 2000). Based on the impact thresholds used for this analysis and the potential to reach water quality standard levels, impacts to water quality (based on human health benchmarks) from benzene would be considered moderate. Impacts to ecological organisms in the river would be considered negligible for all compounds assessed, and impacts related to human health from benzo(a)pyrene would also be negligible.

Backwater Areas — By 2012 cumulative impacts in backwater areas under alternative B would also be similar to cumulative impacts under alternative A because of the continued contributions from the occasional small boats that use these areas. PWC-related incremental contribution to these impacts in backwater areas would be eliminated since PWC use would be restricted upon implementation of a special regulation as proposed in this alternative.

Predicted threshold volumes of water are shown in Table 15. Cumulative impacts from all other boats

TABLE 15: THRESHOLD WATER VOLUMES NEEDED TO DILUTE PWC AND MOTORIZED BOAT EMISSIONS IN BACKWATER AREAS, ALTERNATIVE B

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	3.4	1.4	11	4.4
Naphthalene	1.4	0.54	N/C	N/C
1-methyl Naphthalene	3.9	1.6	N/C	N/C
Benzene	3.3	1.3	350	140

Note: Estimated "typical" backwater area = 48 acre-feet.

N/C – No criteria or benchmark.

to aquatic biota from PAHs and benzene and impacts to biota from benzo(a)pyrene would be negligible. Impacts to human health from benzene (threshold volume of 140 ac-ft) would be considered moderate because the threshold volume is about three times greater than the backwater volume (48 ac-ft), but with volatilization and other removal mechanisms in operation, major impact levels are not expected to occur.

Conclusion. Under alternative B impacts to water quality from PWC-related PAHs that were analyzed and benzene in the main river channel would be negligible to minor in both 2002 and 2012. Reduced PWC emissions by 2012 from phasing-in the use of four-stroke engines would result in negligible impacts to water quality in the river. In backwater areas, after implementation of a special regulation as proposed in alternative B, no impacts to aquatic biota or human health would occur since PWC use would not be permitted in these areas.

Cumulative impacts would be similar to those described for alternative A except that PWC-related incremental contributions to cumulative effects in backwater areas would be eliminated. Impacts to human health from benzene would be moderate through 2012 from all other boats in backwater areas.

Alternative B would not result in impairment to water quality.

Impacts of the No-Action Alternative

Analysis. Under the no-action alternative there would be no water quality impacts from personal watercraft in either the main channel or backwater areas since PWC use would be banned.

Cumulative Impacts. Impacts would be derived solely from motorized boat use. By 2012 emissions from boats on the river are expected to be 50% of current levels in response to the introduction of four-stroke and less-polluting two-cycle engines. The predicted threshold volumes for boats in 2012 are shown in Table 16. The human health related threshold volume for benzene (26,000 ac-ft) would be the only threshold volume greater than the river volume; all other volumes would be substantially lower than the river volume. Consequently, water quality impacts from PAHs would be negligible. Based on an estimated 5-hour half-life for benzene, benzene concentrations in the river due to motorized boats in 2012 are expected to be lower than the human health benchmark in less than 15 hours, and other removal mechanisms would further reduce levels. Therefore, cumulative impacts to

TABLE 16: THRESHOLD WATER VOLUMES NEEDED TO DILUTE MOTORIZED BOAT EMISSIONS IN THE NECHES RIVER, NO-ACTION ALTERNATIVE

	Threshold Volumes (acre-feet) Based on Ecological Benchmarks		Threshold Volumes (acre-feet) Based on Human Health Benchmarks	
Compound	2002	2012	2002	2012
Benzo(a)pyrene	500	250	1,600	800
Naphthalene	200	100	N/C	N/C
1-methyl Naphthalene	580	290	N/C	N/C
Benzene	480	240	52,000	26,000

Note. Estimated static volume of river in study area = 6,030 acre-feet.
N/C – No criteria or benchmark.

water quality in the river and backwater areas from other boat emissions of benzene would be negligible to moderate in 2012. PWC contribution to these impacts would be eliminated since they would no longer be permitted in the preserve.

Conclusion. Impacts from personal watercraft would cease, resulting in a beneficial impact to water quality.

By 2012 cumulative impacts would be negligible to moderate based on other motorized boat use. PWC contribution to these impacts would be eliminated since they would no longer be permitted in the preserve.

The no-action alternative would not result in impairment to water quality.

AIR QUALITY

Personal watercraft emit various compounds that pollute the air. Up to one third of the fuel delivered to current two-stroke engines goes unburned and is discharged as gaseous hydrocarbons; the lubricating oil is used once and is expelled as part of the exhaust; and the combustion process results in emissions of air pollutants such as volatile organic compounds (VOC), nitrogen oxides (NO_x), particulate matter (PM), and carbon monoxide (CO). Personal watercraft also emit fuel components such as benzene and fuel additives that are known to cause adverse health effects. Even though PWC engine exhaust is usually routed below the waterline, a portion of the exhaust gases end up in the air. These air pollutants may adversely impact park visitor and employee health, as well as sensitive park resources. For example, VOC and NO_x emissions, in the presence of sunlight, form ozone. Ozone causes respiratory problems in humans, including cough, airway irritation, and chest pain during inhalations (US EPA 1996b). Ozone is also toxic to sensitive species of vegetation. It causes visible foliar injury, decreases plant growth, and increases plant susceptibility to insects and disease. Carbon monoxide can affect humans as well. It interferes with the oxygen carrying capacity of blood, resulting in lack of oxygen to tissues. NO_x and PM emissions associated with PWC use can also degrade visibility (California Air Resources Board 1997; US EPA 2000). NO_x also contributes to acid deposition effects on plants, water, and soil. However, because emission estimates show that NO_x from personal watercraft are minimal (less than 5 tons per year), acid deposition effects attributable to PWC use are expected to be minimal.

Guiding Regulations and Policies

Clean Air Act. The Clean Air Act establishes national ambient air quality standards to protect the public health and welfare from air pollution. The act also establishes the program for prevention of significant deterioration (PSD) of air quality to protect the air in relatively clean areas. One purpose of this program is to preserve, protect, and enhance air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value (42 USC 7401 et seq.). The program also includes a classification approach for controlling air pollution.

> Class I areas are afforded the greatest degree of air quality protection. Very little deterioration of air quality is allowed in these areas, and the park superintendent has an affirmative responsibility to protect visibility and all other class I area air quality related values from the adverse effects of air pollution.
>
> Class II areas includes all national park system areas not designated as class I. Air quality is protected by allowing limited increases (i.e., allowable increments) over baseline concentrations of pollution for the pollutants sulfur dioxide (SO_2), nitrogen oxides (NO_x), and particulate matter (PM). In no case, however, may pollutant concentrations violate any national ambient air quality standards. Big Thicket National Preserve is designated a class II

area. The PSD permitting program for Big Thicket is administered by the Texas Natural Resource Conservation Committee and applies to defined categories of new or modified stationary sources of air pollution with emissions greater than 100 tons per year and all other sources greater than 250 tons per year.

Conformity Requirements. Areas that do not meet national air quality standards for any pollutant are designated as non-attainment areas. Section 176 of the Clean Air Act states:

> No department, agency, or instrumentality of the Federal Government shall engage in, support in any way or provide financial assistance for, license or permit, or approve, any activity which does not conform to an implementation plan [of that state]. . . . [T]he assurance of conformity to such a plan shall be an affirmative responsibility of the head of such department, agency or instrumentality.

Essentially, federal agencies must ensure that any action taken does not interfere with a state's plan to attain and maintain the national ambient air quality standards in designated non-attainment and maintenance areas. In making decisions regarding PWC use within a designated non-attainment or maintenance area, park managers should discuss their plans with the appropriate state air pollution control agency to determine the applicability of conformity requirements.

Applicable PWC Emission Standards. The Environmental Protection Agency's 1996 rule, which took effect in 1998, adopts a phased approach to reduce emissions. The current emission standards were set at levels that are achievable by existing personal watercraft. The new emission standards for small spark-ignition engines are designed to reduce total hydrocarbon (THC) emissions and thereby reduce VOCs and other toxic pollutants. The relationship between THCs and VOCs is approximately 1.03:1 for two-stroke engines and 0.93:1 for four-stroke gasoline engines (US EPA 1997). The new requirements will result in substantial reductions in VOC emissions as the new technology is phased in. By 2006 PWC manufacturers will be required to meet a corporate average emission standard that is equivalent to a 75% reduction in VOC emissions. The actual reduction in emissions will depend on the sale of lower-emitting personal watercraft, and it is estimated that a 50% emission reduction will be achieved by 2020, and a 75% emission reduction by 2025.

NPS Organic Act and Management Policies. The NPS Organic Act (16 USC 1, et seq.) and the NPS *Management Policies* guide the protection of national park system areas. The Organic Act states that the purpose of national parks

> is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations (16 USC 1).

Under its *Management Policies 2001* the National Park Service will

> seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas (NPS 2000b).

The *Management Policies* further state that the National Park Service will assume an aggressive role in promoting and pursuing measures to protect air quality related values from the adverse impacts of air pollution. In cases of doubt as to the effect of existing or potential air pollution on park resources, the service "will err on the side of protecting air quality and related values for future generations."

The Organic Act and the *Management Policies* apply equally to all areas of the national park system, regardless of Clean Air Act designation. Therefore, the National Park Service will protect resources at

both class I and class II designated units. Furthermore, the NPS Organic Act and *Management Policies* provide protection beyond that afforded by the Clean Air Act's national ambient air quality standards because the National Park Service has documented that specific park air quality related values can be adversely affected at levels below the national standards or by pollutants for which no standard exists.

Methodology and Assumptions

In order to assess the level of PWC air quality impacts resulting from a given management alternative, the following methods and assumptions were used:

1. The national ambient air quality standards and state/local air quality standards (if applicable) were examined for each pollutant.
2. Air quality designations for the surrounding area were determined. If a park, or a portion of a park, was within the boundaries of a non-attainment or maintenance area for a given pollutant, ambient air quality concentrations were assumed to violate the national ambient air quality standards for that pollutant.
3. Local ambient air quality data from monitoring sites within the park, if available, and from the closest monitoring site nearby (within 100 miles) were reviewed. For each pollutant evaluated, the first highest maximum concentration obtained was compared with the national ambient air quality standards.
4. The use of motorized watercraft (both number of visits and hours of operation) at the park unit was determined from seasonal observations and estimations provided by preserve personnel, supplemented by visitation data. The annual number of hours of use by each watercraft type was calculated by multiplying the number of visits by the hours of operation.
5. The rated horsepower, average engine load, deterioration factors, and other relevant parameters for each watercraft type were taken from default assumptions in the EPA NONROAD model. (This model is used to calculate emissions of criteria pollutants from operation of nonroad spark-ignition type engines, including personal watercraft. The model allows assumptions to be made regarding the mix of engine types that will be phased in as new engine standards come into effect and increasing numbers of personal watercraft will be of the cleaner burning four-stroke type. Total hydrocarbon emissions comprise approximately 100% of the VOC for two-stroke engines and 93% of the VOC for four-stroke engines [US EPA 1997; US EPA 2000].)
6. Any reductions in emissions resulting from implementing control strategies were taken into account, as were changes in emissions resulting from increased or decreased usage.
7. Studies regarding ozone injury on sensitive plants found in the national preserve were reviewed.
8. A calculation referred to as SUM06 (ppm-hours) was used for ozone. The highest three-month, five-year average commonly used for the area was determined by reviewing ambient air quality data (available from the NPS Air Resources Division).
9. Visibility impairment was determined from local monitoring data, or from qualitative evidence, such as personal observations and photographs.
10. The air quality impacts of the various alternatives were assessed by considering the existing air quality levels and the air quality related values present, and by using the estimated emissions and any applicable, EPA-approved air quality models. Estimated reductions in hydrocarbon emissions would be the same as those described for water quality.

11. For cumulative impacts, the assessment was completed quantitatively with respect to anticipated use of the national preserve by other recreational watercraft based on emission factors and assumption in EPA's NONROAD model. Types of craft assessed for quantitative cumulative impacts included fishing vessels, with predominantly outboard spark-ignition type engines, and larger vessels and pontoons, with inboard/stern-drive type engines. Other sources of air pollutants in the area were also considered in the cumulative analysis through a review of the state implementation plan, county records, and the use of best professional judgment.

PWC impact thresholds for air quality are dependent on the type of pollutants produced, the background air quality, and the pollution-sensitive resources (air quality related values) present. Impact thresholds may be qualitative (e.g., perceived degradation of visibility) or quantitative (e.g., based on impacts to air quality related values or federal air quality standards, or based on emissions), depending on what type of information is appropriate or available.

Two categories for potential airborne pollution impacts from personal watercraft are analyzed: impacts on human health resources, and impacts on air quality related values in the study area. Thresholds for each impact category (negligible, minor, moderate, and major) are discussed for each impact topic.

STUDY AREA

The study area for the assessment was the general area of PWC use in the preserve and the nearshore area where air pollutants may accumulate. For purposes of this review, the analysis boundary extends 100 feet inland from the river and includes the general area of PWC use. Beyond this 100-foot inland zone, it is assumed air pollutants would dissipate.

IMPACTS TO HUMAN HEALTH FROM AIRBORNE POLLUTANTS RELATED TO PWC USE

The following impact thresholds have been defined for analyzing impacts to human health from airborne pollutants — CO, PM, THC, and ozone (O_3). Sulfur oxides (SO_x) are not included because they are emitted by personal watercraft in very small quantities. Attainment areas and non-attainment / maintenance areas are addressed separately.

Big Thicket National Preserve is in a non-attainment area for ozone; it is in an attainment area for all other national ambient air quality standards. The methodology for non-attainment / maintenance areas incorporates a preliminary analysis of conformity requirements.

Attainment Areas: Impact levels for human health would be as follows:

	Activity Analyzed		Current Air Quality
Negligible:	Emissions would be less than 50 tons/year for each pollutant.	**and**	The first highest 3-year maximum for each pollutant would be less than the NAAQS.
Minor:	Emissions would be less than 100 tons/year for each pollutant.	**and**	The first highest 3-year maximum for each pollutant would be less than the NAAQS.

Moderate:	Emissions would be greater than or equal to 100 tons/year for any pollutant.	**or**	The first highest 3-year maximum for each pollutant would be greater than the NAAQS.
Major:	Emissions would be greater than or equal to 250 tons/year for any pollutant.	**and**	The first highest 3-year maximum for each pollutant would be greater than the NAAQS.

Non-Attainment / Maintenance Areas: Impact levels for human health would be as follows:

Negligible:	There would be a net decrease in emissions from current levels.
Minor:	Emissions would be 0–5 tons/year.
Moderate:	Emissions would be greater than 5 tons/year and less than conformity deminimis levels.*
Major:	Emissions would be greater than or equal to conformity deminimus levels.

Impairment (for both attainment and non-attainment/maintenance areas): Air emissions would contribute to continued violation of national standards. In addition, impacts would

have a major adverse effect on park resources and values;

contribute to deterioration of the park's air quality to the extent the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

* Conformity deminimis levels are levels of emissions below which a federal action in a non-attainment or maintenance area is presumed to conform to a state's implementation plan and would not require further review. Actions in attainment areas are presumed to conform and do not require analysis with respect to deminimis levels. Emission values representing the Clean Air Act conformity deminimis levels are shown below:

Non-Attainment Area (NNA)	Tons/year
Ozone (VOCs or NO_x):	
Serious NAA's	50
Severe NAA's	25
Extreme NAA's	10
Other ozone NAA's outside an ozone transport region	100
Marginal and moderate NAA's inside an ozone transport region:	
VOC	50
NO_x	100
Carbon monoxide: All NAA's	100
SO_2 or NO_2: All NAA's	100
PM_{10}:	
Moderate NAA's	100
Serious NAA's	70
Pb: All NAA's	25

Maintenance Areas	Tons/year
Ozone (NO_x), SO_2 or NO_2: All maintenance areas	100
Ozone (VOCs):	
Maintenance areas inside an ozone transport region	50
Maintenance areas outside an ozone transport region	100
Carbon monoxide: All maintenance areas	100
PM_{10}: All maintenance areas	100
Pb: All maintenance areas	25

Source: 40 CFR CHAPTER 1, sec. 51 853 Applicability

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

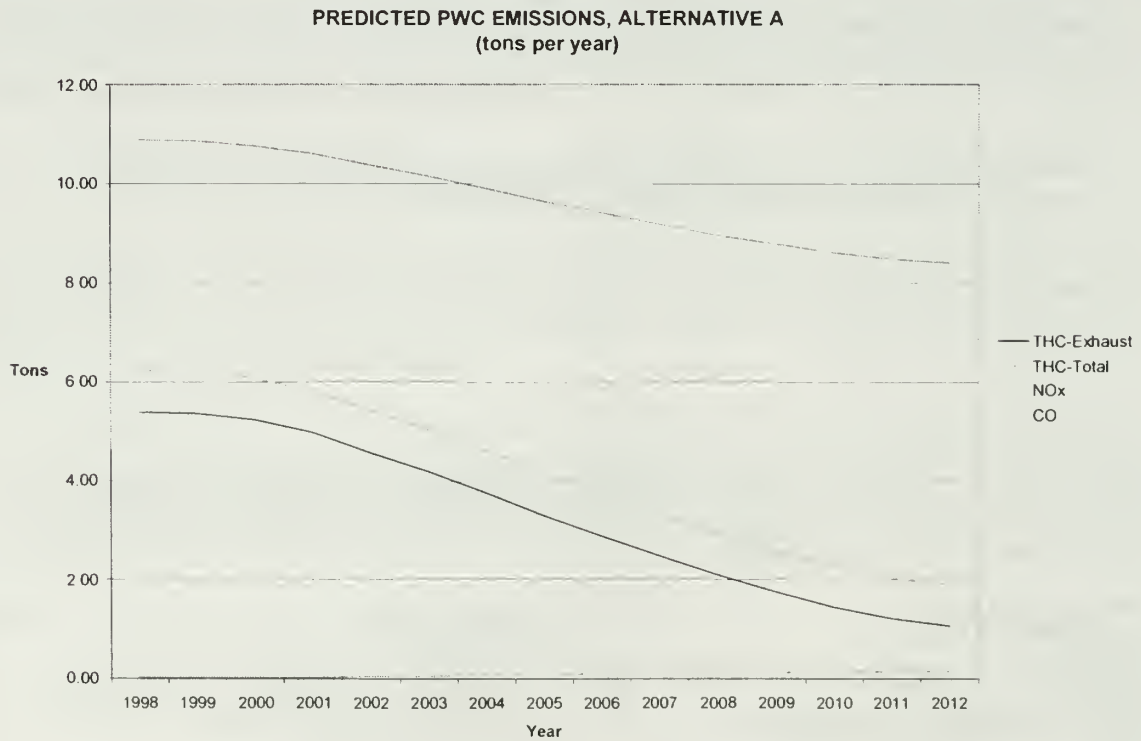
Analysis. PWC use would continue at about current levels and in the same area as now allowed. For Big Thicket the baseline scenario used for analysis was a high-use weekend day with 12 personal watercraft on the river. It was assumed these PWC users would be in the vicinity of the river for 6 to 8 hours, during which time the craft would be operated for 4 hours total time at full throttle (allowing for lunch/beach time). Annual usage was estimated at 1,857 hours per year, based on the estimated usage provided by preserve staff (McHugh, pers. comm. 2001).

Emissions were quantified using the EPA's NONROAD model (US EPA 2000). Results for annual emissions in tons per year for the base year 2000, 2002, and 2012 are presented in Table 17. The trend in emissions over the same time period is shown in the accompanying graph, which generally indicates a decrease as new engine emission standards are phased in.

TABLE 17: ANNUAL PWC EMISSIONS, ALTERNATIVE A

Year	THC	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$
2000	6.06	6.27	0.03	10.77	0.24	0.23
2002	5.41	5.60	0.05	10.39	0.21	0.20
2012	1.89	1.76	0.15	8.4	0.04	0.03

Note: All emissions are based on an assumed 1,857 hours of PWC use for each year.



Results of applying the pollutant specific impact threshold criteria to the air quality data for 2002 and 2012 are shown in Table 18.

TABLE 18: ANALYSIS OF HUMAN HEALTH IMPACTS FOR PWC EMISSIONS, ALTERNATIVE A

Pollutant — Attainment Status	Emission Level (tons/year)		Highest 3-Year Maximum (if applicable)	Impact	
	2002	2012		2002	2012
Ozone (as VOC or NO_x) — Moderate non-attainment	5.60 VOC 0.05 NO_x	1.76 VOC 0.15 NO_x	Ozone measured greater than NAAQS of 125 ppb (134 ppb at Beaumont C2 site in 2000)	Moderate (greater than 5 tons/year but less than 50 tons/year conformity deminimis level)	Minor (less than 5 tons/year)
NO_x — Attainment	0.05	0.15	Less than NAAQS	Negligible	Negligible
PM_{10} — Attainment	0.21	0.04	Less than NAAQS	Negligible	Negligible
CO — Attainment	10.39	8.4	Less than NAAQS	Negligible	Negligible

Ozone (as VOC), for which the area is designated as non-attainment, would exceed emissions of 5 tons per year in 2002, resulting in a moderate impact. In 2002 the ozone standard is predicted to be exceeded on at least one occasion (the same exceedance rate as for year 2000 is assumed). By 2012 this impact would be reduced to minor because of total hydrocarbon emissions being reduced as a result of the Environmental Protection Agency's new emission standards for gasoline powered, spark-ignition engines. In 2012 it is possible that the ozone standard could be exceeded but emissions are predicted to be less than 5 tons per year. The new PWC emissions standards that reduce total hydrocarbons would increase NO_x to a small degree (US EPA 1996b); therefore, a slight increase in NO_x emissions is predicted over time.

Cumulative Impacts. The analysis of cumulative impacts was focused on assessing PWC emissions of ozone precursor chemicals (VOC and NO_x) in combination with all other local and regional sources. Other recreational watercraft that use the national preserve in addition to personal watercraft were assessed quantitatively.

Annual air emissions of THC, VOC, NO_x, CO, PM_{10}, and $PM_{2.5}$ were calculated for smaller fishing vessels, larger boats and pontoons, and personal watercraft in combination. Emission factors and technology type assumptions were obtained either from EPA's NONROAD model default data or from the National Park Service. Projected air emissions from all recreational watercraft, including personal watercraft, are shown in Table 19:

TABLE 19: CUMULATIVE ANNUAL RECREATIONAL WATERCRAFT EMISSIONS, ALTERNATIVE A
(tons per year)

Year	THC	VOC	NO_x	CO	PM_{10}	$PM_{2.5}$
2000	15.60	16.14	2.89	97.23	0.94	0.88
2002	13.99	14.47	2.96	97.39	0.88	0.81
2012	8.12	7.58	3.18	96.74	0.61	0.56

Notes:

Boating activity levels identified in the "Visitor Use and Experience" section are assumed to continue at year 2000 levels for the period analyzed. Emission reductions resulting from increased use of four-stroke engines for both personal watercraft and other recreational types of craft are accounted for in the calculations.

Fishing boat use is assumed at 10,965 hours per year through 2012.

Larger vessel/pontoon use is assumed at 11,196 hours per year through 2012.

PWC emissions are based on an assumed 1,857 hours of PWC use for each year analyzed; results for PWC use alone are shown in Table 17.

The quantitative data for all watercraft were compared to the impact thresholds shown at the beginning of the section. In combination, cumulative air emissions from watercraft are predicted as moderate for all years analyzed for ozone as VOC (an ozone precursor), and minor for NO_x and CO. Emissions of VOC are greater than 5 tons per year but less than the respective major impact thresholds (the Big Thicket Preserve is located in a moderate ozone non-attainment area, and the conformity deminimis threshold is 50 tons per year for VOC). Emissions would be negligible for PM, PM_{10}, and $PM_{2.5}$.

The relative VOC contribution by personal watercraft relative to the overall emissions in the area is very small (based on current county data) and trending downward, given the use levels on the river and emissions from other area sources (TNRCC 2001). In addition to PWC and other recreational watercraft use related emissions, the area receives emissions from regional industries and from other motorized vehicles (cars, RVs, motorcycles) that use the preserve. Other planned activities that could affect PWC use and air quality include the following:

- A new saltwater barrier and boat launch under construction south of Confluence could cause a slight increase in PWC use due to greater park access.
- Changes in seasonal water releases from upstream reservoirs due to the construction of the saltwater barrier and Dam A could increase PWC use slightly due to other sites becoming less suitable for use if and when these actions were implemented.
- Emissions for potentially new industrial facilities, including a new natural gas fired power plant, would be offset by phasing in more stringent emission control requirements for both existing and new industrial point sources of air pollution. These requirements focus on reducing NO_x emissions and bringing the area into attainment with the ozone national ambient air quality standard in 2006 (TNRCC 2000).

These projects, in combination with PWC and other emissions sources in and near the national preserve, are predicted to result in a cumulative regional moderate adverse impact, as evidenced by the area's moderate ozone non-attainment status. However, according to the Texas Natural Resource Conservation Committee, the region will be able to demonstrate attainment in 2006, based primarily on emission standards and controls for major stationary sources (TNRCC 2000). The state's attainment plan for 2006 assumes a small increase in regional PWC use and accounts for new emissions sources planned for the area. Given this, cumulative impacts for ozone would be considered moderate while the area remained in non-attainment, and minor trending toward negligible once ozone attainment status was achieved and emission controls applicable to all area sources came into effect. Cumulative impacts of CO would be minor.

Conclusion. For ozone there would be a moderate impact in 2002 and a minor impact in 2012 under alternative A. (For 2002 the ozone standard could be exceeded once, the same as for year 2000, and VOC emissions could exceed 5 tons per year. For 2012 it is possible that the ozone standard could be exceeded, but emissions are predicted to be less than 5 tons per year.) Negligible impacts are predicted for all other criteria pollutants based on identified impact thresholds (emissions would not exceed 50 tons per year between 2002 and 2012). Emission of any quantity of ozone precursor pollutants below 5 tons per year while the area remained out of attainment with the one-hour ozone standard would result in a minor impact for that particular pollutant.

Cumulative impacts for ozone would be considered moderate while the area remained in non-attainment status. Impacts for all other criteria pollutants would be minor and trending toward negligible once attainment status was achieved and improved emission controls were phased in. PWC contribution to these cumulative impacts would be very small.

This alternative would not result in impairment to air quality.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Under alternative B four-stroke engines would be phased in, with an estimated 90% reduction in total hydrocarbons from PWC emissions by 2012 compared to year 2000. It is assumed for the purposes of impact analysis that this mitigation measure would be effective in 2003. Emissions of the attainment criteria pollutants NO_x, CO, PM, and SO_x would be less than 50 tons per year, with negligible impacts, based on the impact threshold criteria for these pollutants. Predicted emissions for total hydrocarbons and the non-attainment ozone precursor chemical VOC are shown in Table 20.

TABLE 20: ANNUAL PWC EMISSIONS, ALTERNATIVE B
(tons per year)

Year	THC	VOC
2000	6.06	6.27
2002	5.41	5.60
2012	0.61	0.63

Note: A total of 1,857 hours of PWC use are assumed for each year

Alternative B would result in similar impact levels for ozone-related pollution to alternative A for the years selected for analysis (2003 was not included specifically in the analysis). These impact levels would be moderate in 2002 and minor in 2012. The attainment criteria pollutant impacts would be negligible, as emissions would not exceed the 50-ton thresholds.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A, but more reduction in VOC would occur because VOC is directly related to THC, which is the target pollutant for the additional restrictions.

Projected cumulative emissions of VOC from all recreational watercraft based on the additional restrictions are shown in Table 22.

TABLE 21: CUMULATIVE ANNUAL RECREATIONAL WATERCRAFT EMISSIONS, ALTERNATIVE B
(tons per year)

Year	THC	VOC
2000	15.60	16.14
2002	13.99	14.47
2012	6.84	6.44

Note: Annual use levels are assumed at 1,857 hours for personal watercraft; 10,965 hours for fishing boats, and 11,196 hours for larger vessels and pontoons for all years

The impact of PWC use on air quality in combination with other recreational watercraft and other emission sources in the area would remain moderate for ozone under this alternative while the area remains out of attainment with the 1-hour ozone standard, and minor for CO. A small improvement in emissions of other air pollutants is expected in association with the reductions in THC.

Conclusion. Alternative B would result in similar but slightly reduced impact levels compared to those described for alternative A. Accelerating the phase in of four-stroke engines would be beneficial to the preserve's air quality objectives. Pollutants such as THC and VOC are emitted in greater

quantities by two-stroke as opposed to four-strike engines; therefore, emissions of these pollutants would be reduced over the period leading up to 2012, compared to alternative A.

Cumulative impacts would be very similar to those for alternative A and would be considered moderate while the area remained in non-attainment status for ozone, and minor trending toward negligible once attainment status was achieved and improved emission controls were phased in. PWC contribution to cumulative impacts on air quality would be reduced and would remain small.

This alternative would not result in impairment to air quality.

Impacts of the No-Action Alternative

Analysis. Under this alternative PWC emissions within the preserve would be eliminated, resulting in a beneficial impact to air quality.

Cumulative Impacts. Cumulative impacts for the no-action alternative would be similar as those described for alternative A for all other emission sources. PWC contribution to cumulative impacts would be eliminated.

Conclusion. Banning PWC use within the preserve would result in a beneficial impact to air quality.

There would be no incremental cumulative impacts related to PWC use; cumulative impacts from all other sources would be similar to alternative A.

This alternative would not result in impairment to air quality.

Impacts to Air Quality Related Values from PWC Pollutants

The following impact thresholds have been defined for analyzing impacts to air quality related values, which include visibility and biological resources (specifically ozone effects on plants) from airborne pollutants related to PWC use (O_3, NO_x, THC, PM). $PM_{2.5}$ as a fraction of particulate matter is evaluated for visibility impairment. Both VOC and NO_x are ozone precursors in the presence of sunlight and are evaluated separately in lieu of ozone, which is formed as a secondary pollutant.

To assess the impact of ozone on plants, the five-year ozone index value was calculated and is represented as SUM06. National SUM06 values have been developed by the NPS Air Resources Division based on rural and urban monitoring sites. Urban sites are most relevant to Big Thicket, which is close to industries and major highways, and were selected for this analysis.

The following PWC impact levels for air quality related values are assumed:

	Activity Analyzed		Current Air Quality
Negligible:	Emissions would be less than 50 tons/year for each pollutant.	**and**	There would be no perceptible visibility impacts (photos or anecdotal evidence). **and** There would be no observed ozone injury on plants.

			and SUM06 ozone would be less than 12 ppm-hrs.
Minor:	Emissions would be less than 100 tons/year for each pollutant.	**and**	SUM06 ozone would be less than 15 ppm-hrs.
Moderate:	Emissions would be 100–249 tons/year for any pollutant. **or** Visibility impacts from cumulative PWC emissions would be likely (based on past visual observations).	**or**	Ozone injury symptoms would be identifiable on plants. **and** SUM06 ozone would be less than 25 ppm-hrs.
Major:	Emissions would be equal to or greater than 250 tons/year for any pollutant. **or** Visibility impacts from cumulative PWC emissions would be likely (based on modeling or monitoring).	**and**	Ozone injury symptoms would be identifiable on plants. **or** SUM06 ozone would be greater than 25 ppm-hrs.

Impairment: Air quality related values in the park would be adversely affected. In addition, impacts would:

have a major adverse effect on park resources and values;

contribute to deterioration of the park's air quality to the extent the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

For the cumulative analysis, an assessment was made based on the SUM06 index values for ozone and best professional judgment.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. PWC use under alternative A would continue at about current use levels for the next 10 years. The measured ozone level for the area would be 19–25 ppm-hours, as shown in Table 22.

In 2002 measured SUM06 ozone values for the Big Thicket area would be in the range of 19 to 25 ppm-hours, which would represent a moderate impact to plants from long-term ozone exposure. In 2012 it is assumed that SUM06 ozone values would be less than or equal to 19–25 ppm-hours, based on the general trend of reduced emissions for the area (TNRCC 2000), but still above 15 ppm-hours. This would be a moderate impact. Visibility impacts were also considered and were evaluated as a function of fine particulate matter ($PM_{2.5}$) generation. No measurable visibility impairment from PWC use has been identified at Big Thicket, and any adverse impacts to visibility would be negligible.

TABLE 22: AIR QUALITY RELATED IMPACTS FROM PWC EMISSIONS, ALTERNATIVE A

Pollutant	Emission Level (tons/year)		Visibility Threshold / SUM06 Index Value		Impact	
	2002	2012	2002	2012	2002	2012
$PM_{2.5}$ (as fine particulate matter affecting visibility)	0.20	0.03	No perceptible visibility impacts	No perceptible visibility impacts	Negligible	Negligible
Ozone (as a plant growth inhibitor)	5.60 (as VOC) 0.05 (as NO_x)	1.76 (as VOC); 0.15 (as NO_x)	SUM06 index value: 19–25 ppm-hrs (same as nearby urban monitoring sites for year 2000)	SUM06 index value: less than or equal to 19–25 ppm-hrs (assumed to be no greater than measured values for 2000); no evidence of damage	Moderate	Moderate

Source: NPS Air Quality Division.

Cumulative Impacts. Cumulative impacts for ozone for 2002 and 2012 were assessed based on measured SUM06 index values, and a moderate adverse impact is indicated, although no ozone injury has been identified. In 2012 it is assumed that the SUM06 values would be no greater than they are in 2002, based on current emission trends (TNRCC 2000).

Studies of fine particulate matter generation and transport in the region of the southern United States and Mexico have identified south Texas as an area where visibility may be degraded, in particular as a result of the formation of $PM_{2.5}$, primarily from regional industrial sources of SO_x and NO_x (NPS 2001c). The implementation of the Environmental Protection Agency's proposed primary and secondary national ambient air quality standards for $PM_{2.5}$ has been delayed; therefore, no ambient standards for this pollutant are currently applicable. Cumulative impacts to visibility under this alternative would be minor.

Conclusion. Under alternative A, based on SUM06 regional ozone concentrations, ozone impacts on plants would be moderate from 2002 through 2012, and visibility impacts would be negligible.

Cumulative impacts would be considered moderate for ozone effects on plants and minor for visibility.

This alternative would not result in impairment to air quality related values.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Under alternative B phasing in the use of four-stroke PWC engines by 2012 would result in a 90% reduction in total hydrocarbons compared to year 2000. Air quality related resource impacts would be similar to but slightly reduced from those described for alternative A.

Cumulative Impacts. Cumulative impacts would be similar but slightly reduced under alternative B compared to alternative A due to phasing in four-stroke PWC engines. Impacts would be moderate for ozone effects and minor for visibility under alternative B.

Conclusion. Alternative B would result in impact levels that would be similar to, but slightly reduced from, those described for alternative A.

Cumulative impacts would be similar to, but slightly reduced from, those described for alternative A. Impacts would be moderate for ozone effects and minor for visibility.

This alternative would not result in impairment to air quality related values.

Impacts of the No-Action Alternative

Analysis. Because there would be no PWC emissions after April 2002, PWC-related pollutants and resource impacts would be eliminated, resulting in a beneficial impact to air resources.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A and would be moderate for ozone effects and minor for visibility. However, PWC contribution to cumulative air quality impacts would be eliminated under this alternative.

Conclusion. Banning PWC use would eliminate this source of emissions, resulting in a beneficial impact to air quality

Cumulative impacts would be similar to those described for alternative A — moderate for ozone effects and minor for visibility. PWC contribution to cumulative impacts would be eliminated.

This alternative would not result in impairment to air quality related values.

SOUNDSCAPES

All motorized watercraft, including personal watercraft, produce noise that may impact park soundscapes and visitor experiences. Any watercraft that does not meet the NPS watercraft noise regulation of 82 dB at 82 feet at full acceleration is subject to fine and removal from the park. Therefore, it is assumed for this analysis that 82 dB at 82 feet is the maximum that would be emitted for any legal watercraft at full acceleration (normally the "loudest" portion of its operation).

In addition, the noise from personal watereraft might be more noticeable and therefore more impacting to people than other motorcraft due to frequent changes in acceleration and direction, and jumping into the air, causing rapid increases in the noise level and changes in sound frequency distribution.

Guiding Regulations and Policies

The national park system includes some of the quietest places on earth, as well as a rich variety of sounds intrinsic to park environments. These intrinsic sounds are recognized and valued as a park resource in keeping with the NPS mission (NPS *Management Policies 2001,* sec. 1.4.6), and they constitute the preserve's natural soundscape. The natural soundscape, sometimes called natural quiet, is the aggregate of all the natural sounds that occur in a park unit, absent human-caused sound, together with the physical capacity for transmitting the natural sounds *(Management Policies 2001,* sec. 4.9). It includes all of the sounds of nature, such as "non-quiet" sounds of birds calling, waterfalls, thunder, and waves breaking against the shore. Some natural sounds are also part of the biological or other physical resource components of parks (e.g., animal communication, sounds produced by physical processes such as wind in trees, thunder, running water).

NPS policy requires the restoration of degraded soundscapes to the natural condition whenever possible, and the protection of natural soundscapes from degradation due to noise (undesirable human-caused sound) *(Management Policies 2001,* sec. 4.9). The National Park Service is specifically directed to "take action to prevent or minimize all noise that, through frequency, magnitude, or

duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" *(Management Policies 2001,* sec. 4.9). Overriding all of this is the fundamental purpose of the national park system, as established in law, which is to conserve park resources and values (16 USC 1 et seq.). NPS managers must always seek ways to avoid, or to minimize to the greatest degree practicable, adverse impacts on park resources and values *(Management Policies 2001,* sec 1.4.3).

Noise can adversely affect park resources, including but not limited to natural soundscapes. It can directly impact them, for example, by modifying or intruding on the natural soundscape. It can also indirectly impact resources, for example by interfering with sounds important for animal communication, navigation, mating, nurturing, predation, and foraging functions.

Noise can also adversely impact park visitor experiences. The term "visitor experience" can be defined as the opportunity for visitors to experience a park's resources and values in a manner appropriate to the park's purpose and significance, and appropriate to the resource protection goals for a specific area or management zone within that park.

The federal regulation pertaining to noise abatement for boating and water use activities (36 CFR 3.7) prohibits operating a vessel on inland waters "so as to exceed a noise level of 82 decibels measured at a distance of 82 feet (25 meters) from the vessel" and specifies that testing procedures to determine such noise levels should be in accordance with or exceed those established by the Society of Automotive Engineers (SAE) in "Exterior Sound Level Measurement Procedure for Pleasure Motorboats" (J34). This SAE procedure specifies that sound level measurements be taken 25 meters perpendicular to the line of travel of the vessel at full throttle (SAE 2001). It is important to note that this NPS regulation and the SAE procedure were developed for enforcement purposes, not impact assessment purposes. The level in the regulation does not imply that there are no impacts to park resources or visitor experiences at levels below 82 dB; it just indicates that noise levels from vessels legally operating on NPS waters will be no "louder" than 82 dB. As explained elsewhere in this document, a single decibel value does not provide much information for impact assessment purposes.

Methodology and Assumptions

The methodology used to assess PWC-related noise impacts in this document is consistent with NPS *Management Policies 2001, Director's Order #47: Soundscape Preservation and Noise Management,* and the methodology being developed for the reference manual for DO #47. Specific factors at Big Thicket related to context, time, and intensity are discussed below and are then integrated into a discussion of the impact thresholds used in this analysis.

Potential impacts to the soundscape along the lower Neches River were evaluated based on the existing sound levels in comparison to potential sound levels associated with each of the alternatives. This evaluation is a qualitative assessment. Without specific data, a quantitative noise impact assessment is not feasible. The qualitative assessment is based on the general trends of existing and future PWC use in the preserve and best professional judgment.

> **Context:** The resources most likely to be affected by PWC noise at Big Thicket include the park's natural soundscape and noise-sensitive wildlife. Visitor experiences at Big Thicket that would be most likely affected by PWC noise include opportunities to experience solitude and the preserve's natural soundscape unaffected by human noise sources. People in parties associated with PWC use may not be adversely affected, while people not associated with PWC use, even if they are associated with other types of motorized boat activity, may consider

PWC use intrusive. For those who use boats primarily as a means of transport, and then moor their boats to enjoy the destination site in relative isolation, PWC use by another party may adversely affect their visitor experience.

Time Factors: *Time Periods of Interest* — PWC use occurs mostly on 26 weekends during the summer (see Table 5, page 58) and primarily during daylight hours.

Time periods of greater sensitivity to noise impacts include sunset, sunrise and night time when boaters are in camp, perhaps eating or otherwise engaged in quieter pursuits, and when wildlife may be more active, such as coming to the river for water or food.

Duration and Frequency of Occurrence of Noise Impacts — In areas and times of concentrated PWC use, noise from personal watercraft (and other boat types) can be present virtually constantly from near sunrise to near sunset. In areas and times of low use, such noise can be intermittent, usually lasting at least a few minutes when it is present. However, Table 5 (page 58) indicates that on the highest use days (26 days each year), an average of only 12 PWC are used only 4 hours in the entire preserve area.

Intensity: *Characterizing the Park's Natural Soundscape* — As discussed in the "Affected Environment," existing natural ambient sound levels within the project area range from roughly 40 to 43 dBA, which is low and comparable to other areas with similar vegetation height and density and characterized mostly by wind in the trees. The primary human factor affecting the natural soundscape is motorized watercraft along the lower Neches River. Given this, the primary soundscape issue at Big Thicket is the effect of the noise generated by personal watercraft and other motorized watercraft as it affects the natural soundscape and as it is perceived by visitors who appreciate the preserve for natural sounds, quiet, or solitude. Conflicts between anglers and PWC users have been reported, especially in the morning when anglers prefer more quiet waters (see "Visitor Experience").

Characterizing Noise Sources, Including Personal Watercraft — Foch (1999) indicates PWC measurements at Big Thicket consistent with the measurements at Glen Canyon conducted for the National Park Service in August 2001. These measurements were in the range of 68 to 78 dBA at 50 feet, with transient spikes above 80 dBA during rapid turns, jumps, or acceleration.

There is no frequency spectra data available on either the natural soundscape or on personal watercraft or other boats used at Big Thicket.

Context, time, and intensity together determine the level of noise impact for an activity. For example, noise for a certain period and intensity would have a greater impact in a highly sensitive context, and a given intensity would have a greater impact if it occurred more often, or for a longer duration. It is usually necessary to evaluate all three factors together to determine the level of noise impact. In some cases an analysis of one or more factors may indicate one impact level, while an analysis of another factor may indicate a different impact level, according to the criteria below. In such cases, best profession judgment based on a documented rationale must be used to determine which impact level best applies to the situation being evaluated.

As discussed in the "Affected Environment," existing sound levels within the study area range from roughly 40 to 43 dBA, which is low and comparable to an undeveloped, naturally quiet environment. The primary factor affecting these background levels is motorized watercraft along the lower Neches River. Given this, the primary soundscape issue at Big Thicket is the noise generated by personal watercraft and other motorized watercraft as perceived by visitors who use the preserve for quiet or

solitude. (This assessment addresses noise impacts to park visitors only; impacts to wildlife from noise are addressed separately under "Wildlife and Wildlife Habitat.")

The methodology for assessing noise impacts related to PWC is twofold:

1. Existing PWC use is compared to projected PWC use. As discussed in the "Visitor Use and Experience" section, varying numbers of personal watercraft use the lower Neches River corridor during different times of the year (see Table 5, page 58). The highest use occurs on summer weekends (26 days a year) when an average of 12 personal watercraft may use the lower Neches for up to four hours at a time. Projected PWC use is expected to remain roughly the same as it is now, with no substantial increase or decrease in PWC users; therefore, future noise impacts are expected to be approximately the same as the existing baseline conditions.
2. The types of engines currently used along the lower Neches River corridor are compared to the types of engines projected to be used in the future. The majority of personal watercraft now used are two-stroke engines, which typically generate more noise than four-stroke engines (Yamaha Motor 2001). It is assumed that four-stroke engines would gradually replace two-stroke engines used in the preserve over the next 10 years, thereby resulting in lower noise levels.

Because PWC use varies by location, type, and time of use, the following assumptions or factors have been considered in the analysis of impacts to the soundscape of the project area:

1. The number of PWC users along the lower Neches River corridor is assumed to be a total of 12 per day, 26 days per year, which is a conservative estimate based on high use days. It should be noted that for the remaining 339 days of the year, there would be fewer or no PWC users in the area.
2. The location of PWC use primarily occurs around sandbars and boat launches within the lower Neches River corridor, particularly Collier's Ferry (boat launch) and the Lakeview sandbar. PWC use in backwater areas and portions of the river located far away from sandbars and boat launches seldom occurs. Therefore, PWC-related noise impacts were analyzed for the lower Neches River area of the park.
3. The levels of sound generated by motorized watercraft affect users of the area differently. For example, visitors participating in less sound-intrusive activities such as fishing or canoeing would likely be more adversely affected by PWC noise than would visitors using personal or other motorized watercraft. It should be noted, however, that the primary use of the lower Neches River within the project area is the recreational use of motorized watercraft and is seldom used for quiet activities or solitude.
4. The lower Neches River corridor is subject to additional sources of noise other than personal watercraft, including jet boats, ski boats, houseboats, and fishing boats, in addition to noise from traffic and other recreational activities in the vicinity.
5. State water safety regulations stipulate that personal watercraft must be operated a minimum of 50 feet from any person, platform, vessels, or other object, which somewhat reduces the level of noise effects on people on the shore or in other vessels.
6. Noise generated by personal watercraft is generally short term.
7. Noise generated by personal watercraft can be more apparent than other motorized watercraft due to the changes in sound level, frequency, and pitch resulting from a combination of the inherent engine noise with the way such craft are generally operated. For example, a PWC

user performing stunts will produce frequently varied noise levels and pitches, whereas a speedboat passing by will produce a steady, constant noise level.

Study Area

For this impact analysis, the study area has been defined as the waterways along the lower Neches River where PWC use is permitted, including some backwater areas and up to 100 feet inland, where most shoreline-based recreational activities would occur.

Impact to Visitors from Noise Generated by Personal Watercraft

Given this methodology and the accompanying assumptions, the following criteria have been developed to assess the noise impacts for each of the alternatives:

Negligible: Natural sounds would prevail; motorized noise would be very infrequent or absent, mostly unmeasurable.

Minor: Natural sounds would predominate in areas where management objectives call for natural processes to predominate, with motorized noise infrequent at low levels. In areas where motorized noise is consistent with park purpose and objectives, motorized noise could be heard frequently throughout the day at moderate levels, or infrequently at higher levels, and natural sounds could be heard occasionally.

Moderate: In areas where management objectives call for natural processes to predominate, natural sounds would predominate, but motorized noise could occasionally be present at low to moderate levels. In areas where motorized noise is consistent with park purpose and objectives, motorized noise would predominate during daylight hours and would not be overly disruptive to noise-sensitive visitor activities in the area; in such areas, natural sounds could still be heard occasionally.

Major: In areas where management objectives call for natural processes to predominate, natural sounds would be impacted by human noise sources frequently or for extended periods of time at moderate intensity levels (but no more than occasionally at high levels), and in a minority of the area. In areas where motorized noise is consistent with park purpose and zoning, the natural soundscape would be impacted most of the day by motorized noise at low to moderate intensity levels, or more than occasionally at high levels; motorized noise would disrupt conversation for long periods of time and/or make enjoyment of other activities in the area difficult; natural sounds would rarely be heard during the day.

Impairment: The level of noise associated with PWC use would be heard consistently and would be readily perceived by other visitors throughout the day, especially in areas where such noise would potentially conflict with the intended use of that area. In addition, these adverse, major impacts to park resources and values would

contribute to deterioration of the park's soundscape to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. Alternative A assumes the continuation of PWC use along the lower Neches River, the mouth of Pine Island Bayou, and backwater areas. Because these areas are already frequently used by motorized watercraft and recreationists seeking more active uses, the natural sounds are usually disturbed, especially during daytime hours.

On a typical busy summer day up to 12 personal watercraft could be concentrated at popular landing sites such as the Lakeview sandbar in the lower Neches River area. Other visitors would be using the river for skiing, tubing, sightseeing, and enjoying nature, including natural sounds and fishing. Shoreline recreational areas would be frequented by picnickers and swimmers. In general, PWC use would result in noise concentrated around the sandbar and launch areas, with some PWC users making sporadic runs up and down the river and a few venturing into backwater areas.

Overall, PWC noise levels are expected to have minor to moderate adverse impacts to certain visitors at certain locations along the river on days when PWC use was relatively heavy. Visitors, such as anglers, who use the lower Neches River area for quiet pursuits could be adversely affected by PWC noise, depending on the location and duration of the impact. Other visitors along the lower Neches River are primarily motorized watercraft users who would not be affected to a large degree because their vehicles produce similar noise levels.

Minor impacts would occur when PWC use was occasional, e.g., on low-use days or when recreationists were making runs up and down the river farther away from other users. Moderate impacts could occur from concentrated use in one area, where the level of noise and the numerous changes in pitch typical of PWC use could disrupt or disturb some visitors to the extent that they could not fully enjoy their preferred activities. This would occur mainly where PWC use would conflict with other quieter uses, such as fishing or possibly sunbathing near sandbars and launch sites. Due to the small number of days of high use (26 days a year, mostly on summer weekends; see Table 5, page 58, such impacts are generally expected to be temporary and confined to the high use days.

In general, however, areas of high PWC use would not be used by fishermen during the majority of the day or by those seeking a quieter visitor experience, and impacts would most likely be minor to moderate and short term, since PWC use would not be constant throughout the day, and enjoyment of the typical visitor activities in the area would not be compromised.

Cumulative Impacts. All development actions and recreational activities in the preserve have the potential to disturb the natural soundscape and add to the existing sound levels. The sound levels from these actions differ throughout the preserve, ranging from natural sounds in the majority of the preserve, to a more urbanized noise level in the lower Neches River area. In this area there is noise from all types of boats, water recreationists, picnickers, vehicles at launch sites, residences along the shoreline, aircraft, construction activities, and possibly oil and gas exploration. Cumulative impacts under alternative A would continue at minor to moderate levels over the next 10 years in the lower Neches River area. The incremental impact of continuing PWC use would be minor.

Conclusion. Alternative A would result in a continuation of minor to moderate adverse noise impacts along the lower Neches River portion of the study area during times of high PWC use (i.e., 26 days a year). During other times noise impacts associated with PWC use would be minor to negligible. Visitors, such as anglers, who use the lower Neches River area for quiet pursuits could be adversely affected by PWC noise, depending on location and duration of the impact. Other visitors along the

lower Neches River are primarily motorized watercraft users who would not be affected to a large degree because their vehicles produce similar noise levels.

On a cumulative basis impacts would be adverse and would continue at minor to moderate levels over the next 10 years due to the continuation of additional noise sources in the project area, such as motorboats and automobile traffic. The incremental impact of continuing PWC use would be minor.

The soundscape would not be impaired under alternative A.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Alternative B would result in similar types of impacts as described for alternative A, but the impacts from PWC noise would decrease in intensity and would not occur in some of the more noise-sensitive areas of the preserve due to the PWC restrictions under this alternative. Those visitors who use the study area for quiet recreational pursuits would benefit, because noise from personal watercraft would not be present during certain times of the day and in certain locations, reducing adverse impacts to negligible or minor levels. Restricting PWC use to hours after sunrise would eliminate conflicts between PWC users and early morning anglers.

Prohibiting personal watercraft in backwater areas would eliminate this noise source. Noise would continue in those areas most frequently used by personal watercraft, such as around sandbars and near boat launches, but restricting hours of use would reduce the potential for some moderate impacts to other users.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A, but the incremental impact of PWC noise in backwater areas would be eliminated. Restricting PWC use to hours after sunrise would eliminate conflicts between PWC users and early-morning anglers. Other noise sources would continue at a minor to moderate level, with PWC incremental contribution to these impacts remaining negligible to minor overall.

Conclusion. Alternative B would result in a reduction of noise generated by personal watercraft because of restrictions on times and areas of use. Visitors, such as anglers, who use the area for quiet recreational pursuits would especially benefit from the additional PWC time and location restrictions. Other visitors along the lower Neches River are primarily motorized watercraft users who would not be affected, because their motors produce similar noise levels. Overall, impacts would be short term and minor to moderate in intensity.

On a cumulative basis impacts would be adverse and continue at minor to moderate levels over the next 10 years due to the continuation of additional noise sources in the project area, such as motorized boats and automobile traffic. Incremental impacts to backwater area soundscapes from PWC use would be eliminated.

The soundscape would not be impaired under alternative B.

Impacts of the No-Action Alternative

Analysis. Banning PWC use would eliminate this noise source from the preserve in areas currently open to such use. This would be a beneficial impact to the natural soundscape.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A, but noise from PWC use would be eliminated. Depending on the type of activity and its location, potential cumulative noise impacts from all other sources are expected to still range from minor to moderate, similar to alternative A.

Conclusion. Eliminating PWC noise would be beneficial to the soundscape to some degree. Because many of the other visitors along the lower Neches River are also motorized watercraft users, the overall reduction in noise resulting from banning personal watercraft would be relatively small, but this reduction would benefit the visitors who are most bothered by PWC noise levels and changes in pitch that are typical of their operation.

On a cumulative basis impacts from all other sources would continue at minor to moderate levels, but PWC use incremental impacts to these cumulative effects on the soundscape would be eliminated.

The soundscape would not be impaired under the no-action alternative.

WILDLIFE AND WILDLIFE HABITAT

Some research suggests that PWC use impacts wildlife by interrupting normal activities, causing alarm or flight, causing animals to avoid habitat, displacing habitat, and affecting reproductive success. This is thought to be caused by a combination of PWC speed, noise, and ability to access sensitive areas, especially in shallow water. Literature suggests that personal watercraft can access sensitive shorelines, disrupting riparian habitat areas critical to wildlife.

According to some research, personal watercraft have a greater impact on waterfowl and nesting birds because of their noise, speed, and ability to access shallow-water areas more readily than other types of watercraft. This may force nesting birds to abandon eggs during crucial embryo development stages and flush other waterfowl from habitat, causing stress and associated behavior changes.

Guiding Regulations and Policies

The NPS Organic Act, which directs parks to conserve wildlife unimpaired for future generations, is interpreted to mean that native animal life are to be protected and perpetuated as part of a park unit's natural ecosystem. Natural processes are relied on to control populations of native species to the greatest extent possible; otherwise they are protected from harvest, harassment, or harm by human activities. The restoration of native species is a high priority (NPS *Management Policies 2001*). Management goals for wildlife include maintaining components and processes of naturally evolving park ecosystems, including natural abundance, diversity and ecological integrity of plants and animals (*Management Policies 2001,* sec. 4:1).

Methodology and Assumptions

Personal observations of park staff, relevant literature, and best professional judgment were used to determine potential areas of concern and to assess impacts. Preserve staff (Zipp, pers. comm. 2001) provided information on species habitat and distribution within the preserve.

Based on the trends in PWC use anticipated by park staff and area PWC dealers, use is expected to stay at about the same levels as currently experienced in the study area over the next 10 years. Overall,

PWC use levels are low, with estimates of about 12 personal watercraft used in the study area on a busy weekend day.

Study Area

The study area for the analysis is the area where personal watercraft are permitted to operate and the adjoining shoreline, extending up to 100 feet inland, beyond which PWC noise would be considerably reduced.

Impact of PWC Use on Wildlife and Habitat

The following thresholds were used to determine the magnitude of effects on wildlife and wildlife habitat:

Negligible: There would be no observable or measurable impacts to native species, their habitats, or the natural processes sustaining them. Impacts would be of short duration and well within natural fluctuations.

Minor: Impacts would be detectable, but they would not be expected to be outside the natural range of variability and would not be expected to have any long-term effects on native species, their habitats, or the natural processes sustaining them. Population numbers, population structure, genetic variability, and other demographic factors for species might have small, short-term changes, but long-term characteristics would remain stable and viable. Occasional responses to disturbance by some individuals could be expected, but without interference to feeding, reproduction, or other factors affecting population levels. Key ecosystem processes might have short-term disruptions that would be within natural variation. Sufficient habitat would remain functional to maintain viability of all species. Impacts would be outside critical reproduction periods for sensitive native species.

Moderate: Breeding animals of concern are present; animals are present during particularly vulnerable life-stages, such as migration or juvenile stages; mortality or interference with activities necessary for survival can be expected on an occasional basis, but is not expected to threaten the continued existence of the species in the park unit. Impacts on native species, their habitats, or the natural processes sustaining them would be detectable, and they could be outside the natural range of variability for short periods of time. Population numbers, population structure, genetic variability, and other demographic factors for species might have short-term changes, but would be expected to rebound to pre-impact numbers and to remain stable and viable in the long term. Frequent responses to disturbance by some individuals could be expected, with some negative impacts to feeding, reproduction, or other factors affecting short-term population levels. Key ecosystem processes might have short-term disruptions that would be outside natural variation (but would soon return to natural conditions). Sufficient habitat would remain functional to maintain viability of all native species. Some impacts might occur during critical periods of reproduction or in key habitat for sensitive native species.

Major: Impacts on native species, their habitats, or the natural processes sustaining them would be detectable, and they would be expected to be outside the natural range of variability for long periods of time or be permanent. Population numbers, population structure, genetic variability, and other demographic factors for species might have large, short-term declines, with long-term population numbers significantly depressed. Frequent responses to disturbance by some individuals would be expected, with negative impacts to feeding, reproduction, or

other factors resulting in a long-term decrease in population levels. Breeding colonies of native species might relocate to other portions of the park. Key ecosystem processes might be disrupted in the long term or permanently. Loss of habitat might affect the viability of at least some native species.

Impairment: Some of the major impacts described above might be an impairment of park resources if their severity, duration, and timing resulted in the elimination of a native species or significant population declines in a native species, or they precluded the park's ability to meet recovery objectives for listed species. In addition, these adverse, major impacts to park resources and values would

contribute to deterioration of the park's wildlife resources and values to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment: or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. PWC use under alternative A would continue in the lower Neches River and Pine Island Bayou. PWC use is heaviest at launch sites and sandbars (such as the Lakeview sandbar). These areas are also used heavily by other visitors, such as boaters, fishermen, picnickers, and swimmers. PWC users at Big Thicket rarely venture into densely vegetated and shallow backwater areas, since their main focus is open water areas along the main river channel.

Fish and wildlife species could react to PWC noise, the presence of humans, and physical disturbance, or personal watercraft could provide access to wildlife habitat. In addition, emissions of petroleum-based pollutants (e.g., benzene, PAHs) from personal watercraft could affect fish and wildlife directly or indirectly. These impacts are discussed below for the various fish and wildlife that inhabit the preserve.

Fish and Aquatic Invertebrates — Impacts to fish in the lower Neches and Pine Island Bayou from the physical intrusion of personal watercraft would primarily consist of direct or indirect destruction of their habitat and the escape responses of fish in the area of PWC use. These impacts would be of most concern in spawning areas, many of which may be located along the shoreline in shallow areas not frequented by personal watercraft, such as backwater areas. In the backwater areas, where depths of less than four feet occur, impacts from PWC would be minor to moderate, especially if spawning areas were disturbed. Impacts associated with the escape responses of fish would be temporary and minor. Most aquatic invertebrates (mussels, clams, insects) would be found in and on bottom substrates, such that direct impacts from personal watercraft would not occur. Indirect impacts from increased water action and sedimentation would be very localized and minor.

Biological effects to fish and aquatic invertebrates are considered in the establishment of the water quality standards, criteria, or ecological benchmarks used in the water quality assessment, so the prediction of whether standards or criteria could be exceeded indicates the potential for adverse biological effects. (See "Impacts to Water Quality" and section below on impacts from PWC pollutants).

Reptiles and Amphibians — Impacts to reptiles and amphibians would be most likely where personal watercraft or their users would disrupt nesting or breeding sites, and these are not common on the relatively bare sandbars where most PWC landings occur. Some PWC users may venture away from the main public use areas and trample shoreline areas, disturbing or destroying nests, egg masses, or even individuals living on and in river rock and debris along the shoreline. The impacts from these activities are expected to be temporary and minor to moderate at a very localized level.

Pollutants released by personal watercraft tend to bind to sediments and remain in the system, such as PAHs. These are then available for uptake by bottom feeders and other species that eat the bottom feeders and also inadvertently ingest sediments (e.g., snapping turtles). Many of these persistent PAHs are carcinogenic, and there is evidence that they can bioconcentrate from water to aquatic organisms (USFWS 2000). However, evidence for magnification in higher organisms is weak. Generally, PAH metabolism results in a short half-life of these compounds in animal tissue and limits the potential for significant accumulation. A number of studies have examined the potential for PAH biomagnification, but none found it to be a significant process (e.g., McLeese and Burridge 1987; Broman et al. 1990; Connell and Kayal 1995). Suedel et al. (1994) suggest that, in general, there is little evidence of PAH magnification in aquatic food webs.

No criteria or standards have yet been promulgated for PAHs by a regulatory agency, although several ecological screening levels for PAHs in sediments have been published and used. The Texas Natural Resource Conservation Commission lists 4 µg/kg as a screening level for total PAHs (TNRCC 2001), while 1610 µg/kg and 1,600 µg/kg are used by other sources (USGS 2001; MacDonald et al. 2000 in USGS 2001). There are no data for PAHs in sediments at Big Thicket, and it is not possible to predict sediment PAH concentrations from PWC (or boat) use with an acceptable degree of accuracy. However, studies conducted in similar environments showed that the total PAH concentrations found in sediments were less than the benchmark values given above. Mastran et al. (1994) concluded that boating activity does contribute to PAHs in sediments, since they found the highest concentrations of PAHs near marinas during periods of high boating activity. However, the maximum total PAH concentration found was 1,319 µg/kg. Another study sponsored by the U.S. Geological Survey examined 536 sites in 20 major river basins across the United States. One station was in the Trinity River Basin at Romayor, Texas, just west of Big Thicket and in a watershed with very similar land use. All PAHs in sediment were below detection limits at this site. Since the USGS study showed that PAH concentration was highly correlated with surrounding land use, it is likely that locations in the lower Neches River would also have low PAH values and that adverse impacts from PAHs to any reptiles or amphibians would most likely be minor.

Mammals — Few impacts, if any, are expected to mammals, since there is little use of the actual shoreline by PWC users. Those mammals that might be present along the shorelines in areas used by personal watercraft would most likely be either transient visitors from more inland forests (e.g., white-tailed deer) or mammals that generally become acclimated to human intrusion or even become attracted to the food associated with human use (e.g., raccoons, squirrels).

Adverse impacts to aquatic mammals such as beavers, otters, and muskrats would be negligible to minor, since these animals are mobile and avoid the noise and disturbance associated with PWC use and motorboats. Also, their breeding areas are often located in backwater areas or along shorelines that are generally avoided by PWC users.

Birds — Impacts to birds present along the river corridor where PWC use is permitted would vary, depending on the type of bird and the location. Minor to moderate and relatively short-term adverse impacts could occur to birds nesting near highly used picnic/sandbar locations where PWC users

beach their craft. Many of these birds, however, would habituate to regular human presence and noise, reducing impacts to minor levels. According to studies reported in Bowles (1995), the few studies that have tracked bird movements in the presence of noisy disturbances show that birds demonstrate flexibility and often return to normal home usage patterns.

PWC use on the river is more likely to disturb nesting waterfowl and raptors that use the floodplain forest fringe (gulls, herons, storks, osprey, terns, ducks, etc.). These birds would be somewhat less acclimated to noise, which would vary with use levels and amount of river activity. A sudden loud noise from a PWC user coming into an area or accelerating suddenly could elicit escape/flight responses from birds, disrupting nesting and feeding activities. Noise from boats can cause energy loss from the attempt to escape, with reduced reproductive success (Bowles 1995), or the escape can leave eggs or young vulnerable to cold or predation. These impacts would be short term and moderate in nature. This has been the observed case for wood storks, which have been seen temporarily leaving their roosts along the Neches when a loud boat or other source approaches; however, no permanent disruption or population effects have been documented (Zipp, pers. comm.).

Many of the waterbirds at Big Thicket feed on benthic invertebrates and ingest sediments in the process, such as herons, gulls, storks, and ducks, and there would be concerns about effects of PAHs in sediments and bioaccumulation. As previously discussed under "Reptiles and Amphibians," only minor adverse impacts would be expected, based on the literature and results of studies conducted in similar environments that showed low levels of total PAHs.

Cumulative Impacts. PWC use under alternative A would continue in all areas where it has been permitted, including the more sensitive and quieter backwater areas. Also, there would be continued emission of pollutants. In addition to PWC use, numerous other uses occur along the river that add to the disturbance and destruction of wildlife and wildlife habitat within the study area. These include boating, skiing, picnicking, wading and swimming, use of trout lines for fishing, hunting, oil and gas development, logging, and the construction of saltwater barriers and residences in the watershed. There are also point source discharges of pollutants upstream of the area, and non-point runoff of herbicides, sediments, PAHs bound to sediments, and aerial deposition of PAHs from exhaust sources operating in or near the preserve. Many of these activities would not occur within the study area; however, these activities would have effects on available habitat in the overall region.

However, it is not expected that these activities, even cumulatively, would threaten continued survival of any fish or wildlife species currently in the preserve, and no evidence of such an impact has been observed or documented (Zipp, pers. comm.). PWC contribution to cumulative impacts would be negligible considering the scope of other activities in the regions. Also, as described above, no cumulative adverse impacts from PAHs in sediments would be expected to any wildlife species, based on values reported in the literature from similar environments. Most adverse impacts would be minor to moderate, and they would be limited to the time during which the disturbance occurred.

Conclusion. Continued PWC use in all areas along the lower Neches River could result in minor to moderate direct and indirect adverse impacts on wildlife and waterfowl from PWC-generated noise, physical disturbance, and emissions.

Cumulative adverse impacts would be minor to moderate, and they would be limited to the time during which the disturbance occurred. PWC contribution to these cumulative effects would be negligible.

No impairment would occur to fish or wildlife resources.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. The type and magnitude of impacts to fish and wildlife under alternative B would be similar to those described for alternative A, except that additional restrictions in areas and time of use, and the accelerated phase-in of four-stroke engines, would reduce the magnitude of adverse impacts. Direct impacts to the backwater areas that would be off-limits to PWC use under this alternative would be eliminated. The phasing-in of four-stroke engines or engines with advanced noise controls could reduce noise impacts, since some models are reported to be quieter than their two-stroke counterparts (Sea-Doo 2001b; Yamaha Motor 2001). Also, there would be less unburned oil/gas mixture released and a substantial reduction in hydrocarbons in exhaust, which would reduce the amount of oil-based pollutants available to adhere to sediments and potentially cause adverse effects through bioaccumulation. The timing restrictions under alternative B would also reduce impacts to wildlife that use the river more during early morning hours and dusk, when many animals are more active. There would also be beneficial impacts due to the restriction of PWC use in some areas and during certain times.

Cumulative Impacts. Cumulative impacts under alternative B would be similar to those described for alternative A. However, the contribution to these impacts in backwater areas by PWC use would be eliminated. The requirement to use four-stroke engines would reduce impacts from personal watercraft and limit impacts to minor to moderate levels along the main river channels. Overall, cumulative impacts would be minor to moderate and limited in duration.

Conclusion. Compared to alternative A, alternative B would have some beneficial effects to wildlife and waterfowl from limits on PWC use at certain times and in certain locations. Impacts to wildlife in backwater areas from PWC use would be eliminated. In general, adverse impacts to most fish and wildlife species from PWC use would be negligible to minor.

Cumulative impacts would be similar to, but slightly less, than those described for alternative A due to prohibiting the use of backwater areas and restricting use during early morning and dusk, when wildlife are most abundant and most vulnerable. The incremental contribution of personal watercraft to cumulative impacts in backwater areas would be eliminated, which would most likely have a beneficial effect on wildlife.

No impairment would occur to fish or wildlife resources.

Impacts of the No-Action Alternative

Analysis. Beneficial impacts could occur since PWC use would be prohibited in the national preserve under this alternative. For example, it is possible that areas subject to direct or indirect impacts from PWC use could be reinhabited or used by waterfowl or other birds, reptiles, and amphibians more frequently than under the other alternatives.

Cumulative Impacts. Cumulative impacts under the no-action alternative would be similar to those described for the previous two alternatives (minor to moderate), but the ban on personal watercraft would eliminate impacts related to PWC use.

Conclusion. The no-action alternative would have beneficial impacts to wildlife and waterfowl due to the ban of PWC use. The minor reduction in noise could positively affect wildlife, particularly in areas of frequent PWC use, resulting in potential reinhabitation or use of these areas by wildlife and waterfowl.

PWC contributions to cumulative impacts would be eliminated. Cumulative impacts on fish and wildlife would be similar to those described for alternative A from other sources of impacts.

No impairment would occur to fish or wildlife resources.

THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

Personal watercraft may harm threatened or endangered species and/or their habitat. Of particular concern relative to PWC use at Big Thicket National Preserve are the paddlefish and wood stork.

GUIDING REGULATIONS AND POLICIES

The Endangered Species Act (16 USC 1531 et seq.) mandates that all federal agencies consider the potential effects of their actions on species listed as threatened or endangered. If the National Park Service determines that an action may adversely affect a federally listed species, consultation with the U.S. Fish and Wildlife Service is required to ensure that the action will not jeopardize the species' continued existence or result in the destruction or adverse modification of critical habitat.

Informal consultation was initiated with the U.S. Fish and Wildlife Service during the internal and public scoping period for this project. A list of species that are known to occur or may occur within or adjacent to PWC use areas within the preserve was requested. The response from the U.S. Fish and Wildlife Service is included in appendix B.

An analysis of the potential impacts to each species listed in the letter is included in this section. At Big Thicket it has been determined that none of the alternatives would adversely affect any of the listed species. The completed environmental assessment will be submitted to the U.S. Fish and Wildlife Service for its review. If the agency concurs with the finding of the National Park Service, no further consultation will be required.

Formal consultation would be initiated if the National Park Service determined that actions in the preferred alternative are likely to adversely affect one or more of the federally listed threatened or endangered species identified in the preserve. At that point a biological assessment would be prepared to document the potential effects. From the date that formal consultation was initiated, the Fish and Wildlife Service would be allowed 90 days to consult with the agency and 45 days to prepare a biological opinion based on the biological assessment and other scientific sources. The Fish and Wildlife Service would state its opinion as to whether the proposed PWC activities would be likely to jeopardize the continued existence of the listed species or to result in the destruction or adverse modification of critical habitat. Such an opinion would be the same as a determination of impairment. To ensure that a species was not jeopardized by PWC activities, the Park Service would confer with the Fish and Wildlife Service to identify recommendations for reducing adverse effects and would integrate those into the preferred alternative.

NPS *Management Policies 2001* state that potential effects of agency actions will also be considered on state or locally listed species. The National Park Service is required to control access to critical habitat of such species, and to perpetuate the natural distribution and abundance of these species and the ecosystems upon which they depend.

The species at Big Thicket National Preserve that have the potential to be affected by proposed PWC management alternatives include species that are known to inhabit or are likely to inhabit the area, plus those that could possibly be found in the area, but they would most likely be transients or migrants.

Assumptions and Methodologies

Primary steps in assessing impacts on listed species were to determine

1. which species are found in areas likely to be affected by management actions described in the PWC alternatives
2. current and future use and distribution of personal watercraft by alternative
3. habitat loss or alteration caused by the alternatives
4. displacement and disturbance potential of the actions and the species' potential to be affected by PWC activities

The information contained in this analysis was based on best professional judgment and observational data provided by preserve staff and experts in the field (as cited in the text), and by conducting a literature review.

Study Area

The study area for the analysis is the area where personal watercraft are permitted to operate and the adjoining shoreline, extending up to 100 feet inland, beyond which PWC noise would be considerably reduced.

Impact of PWC Use on Such Species

The Endangered Species Act defines the terminology used to assess impacts to listed species as follows:

> *No effect:* A proposed action would not affect a listed species or designated critical habitat.
>
> *May affect / not likely to adversely affect:* Effects on special status species would be discountable (i.e., extremely unlikely to occur and not able to be meaningfully measured, detected, or evaluated) or completely beneficial.
>
> *May affect / likely to adversely affect:* When an adverse effect to a listed species might occur as a direct or indirect result of proposed actions and the effect would either not be discountable or completely beneficial.
>
> *Is likely to jeopardize proposed species/adversely modify proposed critical habitat (impairment):* The appropriate conclusion when the National Park Service or the U.S. Fish and Wildlife Service identify situations in which PWC use could jeopardize the continued existence of a proposed species or adversely modify critical habitat to a species within and/or outside park boundaries.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. Impacts to any listed fish or wildlife species would be of the same type as those described for wildlife in general. Individual analyses for each species of special concern that was discussed in the "Affected Environment" chapter are provided below.

The species are grouped into those that are known or are likely to occur in the study area (the area of permitted PWC use), and those that could possibly occur, but are not considered likely to be present. The analyses address both current and cumulative impacts and use the definitions in section 7 of the Endangered Species Act (provided above) as the basis of the conclusions.

Species Likely to Occur in the Study Area

Paddlefish. PWC use is not expected to have any impact on paddlefish from direct collision, since personal watercraft have no propellers and sit relatively high in the water. Disturbance to spawning habitat could occur, but given the small number of personal watercraft used and the depth of typical gravel spawning habitat in the study area, both direct and indirect effects would be minor (Zipp, pers. comm. 2001; Maxey, pers. comm. 2001).

Impacts to fish species that would result from the release of pollutants into the water are taken into account in the water quality analysis, since these impacts are accounted for in setting the water quality criteria, standards, or toxicity benchmarks used in the analysis. Additional concerns relating to phytotoxicity of PAHs are not relevant at Big Thicket, because of the high turbidity of the river waters, which blocks the penetration of light that causes phototoxicity. Therefore, no major impacts are expected due to phototoxic effects on phytoplankton, the main diet item for paddlefish.

Cumulative impacts to paddlefish include the direct taking of fish by humans, direct and indirect effects of other water quality deterioration in the river (e.g., low dissolved oxygen levels), construction in the river, effects from boat use, and effects from the alteration in river hydrology that has occurred due to upstream dams. The altered hydrology in the Neches River is probably the main contributor to adverse impacts to paddlefish, since it has resulted in the elimination of many shallow gravel bars that are required by the paddlefish for spawning (Maxey, pers. comm. 2001). However, cumulative impacts to paddlefish are not considered major or threatening to the population in the study area.

Alligator Snapping Turtle. The alligator snapping turtle primarily stays on the bottom of the lower Neches River and its tributaries; therefore; direct impacts to the animal or its habitat would not occur. The minor amount of additional sedimentation caused by PWC wakes would not adversely affect the turtle, which prefers muddy substrates. As described in the general wildlife section, pollutants discharged by personal watercraft that adhere to sediments are not expected to be problematic, since these are not expected to bioaccumulate, and studies in similar environments have not shown total PAH concentrations above ecological screening levels.

Cumulative impacts to the snapping turtle include direct taking of turtles by humans (poaching), deaths from entanglement in trout lines, and effects of other sources of pollutants on and around the Neches River. However, recent surveys by qualified biologists have indicated that snapping turtle populations are more widespread than previously believed, and the prevailing viewpoint is that the species may not be threatened (Zipp, pers. comm. 2001).

Wood Stork. Individual wood storks, which are known to roost along the Neches River, could be temporarily disturbed by PWC use over the years. This would not result in any permanent disturbance or loss of species viability, given the few numbers of personal watercraft on the river and the wider range of available habitat on the Neches and its tributaries. Storks disturbed along the river by boat activity generally fly off, but return to their nests, with no permanent disturbance noted (Zipp, pers. comm. 2001). Similar to the snapping turtle, even though these birds feed on aquatic invertebrates and insects and ingest sediments, the likelihood of adverse impacts from PAHs in sediments is small.

Cumulative impacts to the wood stork include takings by humans, loss of habitat in the area due to development and logging, and decline in water quality. Together, these have had the effect of limiting areas used by the wood stork, but PWC use has not been a substantial part of that effect. Stork populations in Big Thicket seem to be stable over the years (Zipp, pers. comm. 2001).

American Swallowtail Kite. The analysis is the same as for the wood stork, although no kites have ever been observed in the study area. Kites become easily habituated to human noise (a nest was found in a local schoolyard) (Zipp, pers. comm. 2001).

Peregrine Falcon. The peregrine falcon is a transient during migrations only; impacts would be negligible to minor since they do not use the study area for nesting or permanent habitat. Cumulative impacts could occur from reduction in habitat and the possible contamination of food sources throughout their range, but there is little effect on this species in the Neches River system.

Species That Could Possibly Occur in the Study Area

Caddisfly, Dragonfly, Texas Heelsplitter. It is unlikely that the two flies would be found within the study area, because of what is known about their distribution and the general quality of aquatic habitat in the area; however, their potential presence cannot be completely discounted. If present, these species would not be directly affected by PWC use; indirect impacts would be primarily related to the discharge of pollutants and the accumulation of PAHs in sediments. The water quality analysis indicates that the criteria for aquatic life would not be a problem except in some shallow backwater areas. Similar impacts would be relevant for the Texas heelsplitter, which is not known within the study area. Cumulative impacts to all these species would occur from river sedimentation and low oxygen levels, which are not primarily associated with PWC use.

Texas Diamondback Terrapin and Timber Rattlesnake. Neither reptile has been documented as a permanent inhabitant of the study area. Each could occur as a transient, ether in the brackish marshes and riparian areas to the south of Confluence (the terrapin), or along shorelines (the rattlesnake). Since personal watercraft do not land in marshes or thickly vegetated shorelines, impacts would be minor at most. Cumulative impacts would include human and industrial (logging) disturbance in and along the river floodplain forests.

Black Bear, Rafineque's Big-Eared Bat, Southeastern Myotis. All of the mammals could be transients, but not permanent residents of the study area. Personal watercraft would not have any more than minor impacts to bears occasionally coming to the water's edge, or bats flying overhead, especially since personal watercraft are not used after dark. Bats may roost in hollow trees within the floodplain forest, but PWC use on the river would not have more than minor effects on the bats, since the craft stay away from heavily treed shorelines. On a

cumulative basis, logging, hunting, and human presence would be contributors to adverse effects over time.

Brown Pelican, Bald Eagle, White-Faced Ibis, Piping Plover. The first three birds, if present, would be transients or migrants, but not permanent residents of the study area. PWC use would not have any more than minor impacts to bald eagles occasionally feeding in the area, or transient pelicans that venture up the river to the preserve boundary. White-faced ibis would also be rare transients, with no impacts expected on nesting birds or populations. The piping plover could nest on more isolated sandbars or islands in the river, although none has been documented in the preserve, and the more remote sandbars or islands are in areas not frequented by PWC users. More likely, any plovers that would occur in the study area would be transients moving inland from the coast. Cumulative effects to these transient species include human presence and other river-based recreational uses, which would all contribute to minor adverse effects on the birds.

Conclusion. Based on the analyses presented for each species above, actions under alternative A may affect, but are not likely to adversely affect, any of the listed species that are likely to occur or could possibly occur in the study area. While some adverse impacts could result from the activities analyzed, none of these impacts would be of sufficient duration or intensity to cause anything except short-term effects on the listed species. This conclusion is valid for both PWC actions alone and cumulative effects that include other actions.

This alternative would not result in an impairment to any listed species expected to occur in the preserve.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Impacts would be the same as those described for alternative A for all species discussed. However, there would be less chance of impacts to those species present in backwater areas or for individuals that are more active in early morning or late afternoon hours, which is common for many of the listed species. Also, noise from four-stroke engines in newer PWC models would lessen chances of impacts to birds roosting along the main river channels.

Conclusion. Similar to alternative A, the actions under alternative B may affect, but are not likely to adversely affect, any of the listed species that are likely to occur or could possibly occur in the study area. While some adverse impacts could result from the activities analyzed, none of these impacts would be of sufficient duration or intensity to cause anything except short-term effects on the listed species. This conclusion is valid for both PWC actions alone and cumulative effects that include other actions. Some adverse impacts would be mitigated under this alternative with timing restrictions and the elimination of PWC use in backwater areas.

No impairment would occur to any listed species under this alternative

Impacts of the No-Action Alternative

Analysis. Banning PWC use under this alternative would eliminate effects to listed species from PAH impacts related to PWC fuel and exhaust. Cumulative effects would be similar to those for alternative

A; however, PWC contributions to these effects would be eliminated, which would be beneficial over the long term.

Conclusion. Banning PWC use would eliminate the potential for adverse affects on listed species, which would be a beneficial impact.

Cumulative effects would be similar to those described for alternative A.

No impairment would occur to any of the listed species.

SHORELINES AND SHORELINE VEGETATION

PWC users are able to access areas where most other motorized craft cannot go, which may disturb sensitive plant species. In some areas, personal watercraft can be landed on the shoreline, allowing visitors access to areas where sensitive plant species exist. In addition, wakes created by personal watercraft may affect shorelines and cause erosion.

Guiding Regulations and Policies

Natural shoreline processes such as erosion, deposition, and shoreline migration should continue without interference within a park unit (NPS *Management Policies 2001*). Where the nature or rate of natural shoreline processes has been altered, park managers are directed to identify alternatives for mitigating the effects of such activities or structures and for restoring natural conditions.

Methodology and Assumptions

Potential impacts to shoreline vegetation and to the shoreline itself (erosion that can affect shoreline communities) were evaluated based on the pattern of use of motorized watercraft on the Neches River, the nature of the shoreline and the vegetation present, and the professional judgment and observations of the project team members and preserve staff.

According to input obtained from Big Thicket staff and local PWC dealers, it is reasonable to estimate that PWC use would continue at the same level as currently experienced and would not increase at the level anticipated in park units with a stronger focus on motorized watercraft recreation. The current level of PWC use is relatively low, with only about 12 personal watercraft used in the study area during a typical high-use day.

Study Area

The study area for the assessment included the immediate water/land interface along the portions of the Neches River and Pine Island Bayou where PWC use is allowed.

Impacts on Shorelines / Shoreline Vegetation from PWC Use or Shoreline Access

The following thresholds were established:

Negligible: Impacts would have no measurable or perceptible changes in plant community size, integrity, or continuity.

Minor: Impacts would be measurable or perceptible and localized within a relatively small area. The overall viability of the plant community would not be affected and, if left alone, would recover.

Moderate: Impacts would cause a change in the plant community (e.g., abundance, distribution, quantity, or quality); however, the impact would remain localized.

Major: Impacts to the plant community would be substantial, highly noticeable, and permanent.

Impairment: PWC use would contribute substantially to the deterioration of the shoreline or shallow water environment to the extent that the park's shoreline or submerged vegetation would no longer function as a natural system. In addition, these adverse major impacts to park resources and values would:

contribute to deterioration of these resources to the extent that the park's purpose could not be fulfilled as established in its enabling legislation;

affect resources key to the park's natural or cultural integrity or opportunities for enjoyment; or

affect the resource whose conservation is identified as a goal in the park's general management plan or other park planning documents.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. PWC use would continue as currently regulated under alternative A, following trends in use anticipated over the next 10 years. PWC users primarily stay in the main (central) river channel, generally riding in more open water areas and avoiding snags and other shoreline obstacles. Some may enter backwater areas or come close to the shoreline. They do not land on the shoreline except on sandbar areas, which are popular for picnicking, launching, and recreation. This is primarily because of the nature of the shoreline, which consists of a thick floodplain forest with few scattered pockets of emergent marsh (see Photos 3 and 4 in the "Affected Environment"). The shoreline often consists of steep cut banks held in place by the exposed roots of the trees and shrubs that comprise the floodplain forest. The steep banks, along with the other "natural barriers" (such as snakes, mosquitoes, biting flies, poison ivy, alligators, and other wildlife) present along shorelines that tend to keep PWC operators away. For these reasons, adverse impacts to shoreline vegetation would be negligible, with no direct or indirect impacts to the viability of shoreline plant communities expected.

The amount of riverbank erosion attributable to personal watercraft would also be considered negligible to minor, based on observations of relative wake sizes and use patterns. Wakes from personal watercraft do not approach the size of wakes from larger motorboats and can be relatively small at the higher speeds at which they tend to be used. Although some riverbank erosion would be expected to result from PWC wakes, adverse impacts would be minor.

Cumulative Impacts. Other motorized watercraft produce wakes that affect the shoreline and vegetation. Wakes from larger motors generally exceed those created by smaller-sized engines, although wake size also varies with speed and load. The other primary factor that affects shoreline vegetation and bank stability is the flooding regime on the Neches River, which varies considerably with the season and with the decisions made regarding releases from upstream dams. Adverse impacts to

riverbanks and vegetation could occur if flooding was of such a high intensity that banks were croded and vegetation communities permanently changed. PWC incremental contribution to shoreline changes, when combined with other factors, would be negligible. Cumulative impacts to shorelines and shoreline vegetation from all factors affecting these resources would be minor to moderate, with no permanent change in shoreline plant communities.

Conclusion. Impacts to shorelines and shoreline vegetation from PWC use under alternative A would be negligible, given the nature of the shoreline (which deters landings), the relatively few number of personal watercraft used on the river, and the way in which they are used (primarily in the main channel/open areas).

Cumulative impacts would include effects from other motorized craft and the flooding regime on the river and would be considered minor to moderate, depending on the level and frequency of flooding.

No impairment to shorelines or shoreline vegetation would occur.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Under this alternative impacts to the shorelines and shoreline vegetation would be negligible within the main channel. As described for alternative A, impacts would be limited by the relatively low levels of PWC use. Under alternative B PWC users would not be allowed in backwater areas or anywhere in early morning hours. These additional measures would serve to limit PWC use to the main channel and make operators more aware of impacts related to getting too close to shorelines or small marshy areas bordering the shorelines. Also, banning PWC use in backwater areas would eliminate potential impacts to many of the smaller marshes that are more common in stiller, shallow waters, which would be beneficial to these resources

Cumulative Impacts. Cumulative impacts would be similar to those as described for alternative A along the main river channel, which would continue to be open to PWC use as well as other motorized watercraft. Wakes from larger motorboats generally exceed those caused by personal watercraft. Impacts from high velocity flooding would have a greater effect on shorelines and vegetation than recreational uses. PWC contribution to cumulative impacts to the backwater areas would be eliminated. Overall, cumulative impacts would be minor to moderate, depending mostly on the flooding regime imposed by upstream dam releases and natural floods.

Conclusion. Impacts to shorelines and shoreline vegetation under alternative B would be negligible, since PWC use would be restricted to the main river channel. Banning PWC in backwater areas would eliminate potential impacts to many of the smaller marshes that are more common in stiller, shallow waters, which would be beneficial to these resources.

PWC-related contributions to cumulative impacts to the backwater areas would be eliminated. Overall, cumulative impacts would be minor to moderate, dependent mostly on the flooding regime imposed by upstream dam releases and natural floods.

No impairment to shorelines or shoreline vegetation would occur.

Impacts of the No-Action Alternative

Analysis. Banning PWC use would eliminate related impacts to shorelines and shoreline vegetation entirely, resulting in some beneficial effects to these resources. These benefits would primarily occur in backwater areas because banning PWC there would eliminate potential impacts to many of the smaller marshes that are more common in stiller, shallow waters.

Cumulative Impacts. Cumulative impacts would be similar to those described for alternative A for all other sources. PWC contribution to cumulative impacts would be eliminated.

Conclusion. PWC-related impacts to the shoreline bank and shoreline vegetation would cease, resulting in some beneficial effects to these resources, especially in backwater areas.

Cumulative impacts from other sources would be minor to moderate and associated mainly with the river flooding regime, similar to alternative A. PWC contribution to cumulative impacts would be eliminated.

No impairment to shorelines or shoreline vegetation would occur.

VISITOR USE AND EXPERIENCE

Personal watercraft are viewed by some segments of the public as a nuisance due to their noise, safety hazards, operational style, and overall environmental effects. Other visitors believe that personal watercraft are no different from other motorcraft and that PWC operators have a right to enjoy their selected recreational activity.

GUIDING REGULATIONS AND POLICIES

NPS *Management Policies 2001* state that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all parks and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the parks. Because many forms of recreation can take place outside a national park setting, the National Park Service will therefore seek to

- provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in a particular park unit
- defer to local, state, and other federal agencies; private industry; and non-governmental organizations to meet the broader spectrum of recreational needs and demands that are not dependent on a national park setting

Unless mandated by statute, the National Park Service will not allow visitors to conduct activities that

- would impair park resources or values,
- would create an unsafe or unhealthful environment for other visitors or employees,
- are contrary to the purposes for which the park was established, or
- would unreasonably interfere with the atmosphere of peace and tranquillity, or the natural soundscape maintained in wilderness and natural, historic, or commemorative locations within

the park; NPS interpretive, visitor service, administrative, or other activities; NPS concessioner or contractor operations or services; or other existing, appropriate park uses

Part of the purpose of Big Thicket is to offer opportunities for recreation, education, inspiration, and enjoyment. Its significance lies in the spectacular and diverse ecology of the area, in addition to the recreational opportunities available, such as boating along the lower Neches River. The establishing legislation for Big Thicket National Preserve states that public enjoyment is to be provided by maintaining a safe and healthful environment for visitors and employees. To achieve this, Big Thicket strives to maintain and enhance visitor satisfaction and safety.

Methodologies and Assumptions

The purpose of this impact analysis was to determine if PWC use at Big Thicket is (1) compatible with desired visitor experience goals, and (2) the purpose of the preserve as identified in the enabling legislation, as well as other laws and policies affecting visitor use. To determine visitor experience goals, visitor surveys and staff observations were evaluated to determine visitor attitudes and satisfaction in areas where personal watercraft are encountered (see PWC user trends, page 58). This information was then compared to the current level of PWC use to indicate the presence of any conflicting visitor uses. Finally, the alternatives were assessed based on their compatibility with the purpose or enabling legislation of Big Thicket. Impacts were evaluated qualitatively, based on best professional judgment.

The potential for change in visitor experience was evaluated by identifying projected increases or decreases in both PWC and other visitor uses, and determining whether these projected changes would affect the desired visitor experience and result in greater safety concerns or additional user conflicts.

Study Area

The area of PWC use for this impact analysis was defined as the waterways along the lower Neches River, including some backwater areas and up to 50 feet inland where PWC users may walk and where PWC noise begins to dissipate (i.e., noise is muffled by vegetation).

Impact of Personal Watercraft on Visitor Experience Goals

The following thresholds for evaluating impacts on visitor experience were defined:

Negligible: Visitors would not likely be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources.

Minor: Visitors would likely be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources; however the changes in visitor use and experience would be slight and likely short term. Other areas in the park would remain available for similar visitor experience and use without derogation of park resources and values.

Moderate: Visitors would be aware of the effects associated with changes proposed for visitor use and enjoyment of park resources. Changes in visitor use and experience would be readily apparent and likely long term. Other areas in the park would remain available for similar visitor experience and use without derogation of park resources and values, but visitor

satisfaction might be measurably affected (visitors could be either satisfied or dissatisfied). Some visitors who desire to continue their use and enjoyment of the activity/visitor experience would be required to pursue their choice in other available local or regional areas.

Major: Visitors would be highly aware of the effects associated with changes proposed for visitor use and enjoyment of park resources. Changes in visitor use and experience would be readily apparent and long term. The change in visitor use and experience proposed in the alternative would preclude future generations of some visitors' enjoyment of park resources and values. Some visitors who desire to continue their use and enjoyment of the activity/visitor experience would be required to pursue their choice in other available local or regional areas.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. PWC use under alternative A would continue to be allowed within the preserve (including backwater areas). Most of the water recreation in the lower Neches River and Pine Island Bayou up to Cook's Lake is dominated by motorized watercraft used for pleasure and general recreation and fishing boats. Motorized watercraft, including personal watercraft used for pleasure, tend to travel along the Neches River corridor and use the river at all times during the day, while fishing boats tend to remain in one area and are present primarily during the morning hours when the other motorboats are not present. Other types of watercraft (including canoes) are rare in this area because there are designated canoe routes elsewhere in the preserve that are more conducive to nonmotorized watercraft. However, there is a backwater area off Pine Island Bayou, not far from its confluence with the Neches River, where canoeing and bird-watching occur. Staff at Big Thicket have received some complaints about PWC users, which include general rowdiness, noise, lack of consideration for fishermen and their lines, and choppy water (near the Collier's Ferry boat ramp especially) that makes it difficult for other watercraft to launch or dock.

Under these conditions visitors who enjoy using personal watercraft on the lower Neches River would continue to use the area for this purpose. Those visitors who enjoy the area for more passive activities such as fishing could continue to do so; however, their experiences could be affected by continued PWC use at specific locations and time of day, especially in the early morning hours. Continued use at current projected levels would have no impact to those visitors who use and experience park resources on personal watercraft. For other park visitors, especially anglers who desire to experience park resources and values without conflict from PWC users, impacts would be long term and minor to moderate since these uses would continue.

Cumulative Impacts. Various activities potentially have a cumulative effect on visitor use and enjoyment of park resources. For the lower Neches River in particular, those activities include continued motorized recreational boating, as well as more passive uses, such as fishing, camping, and swimming. Under alternative A the continued use of personal watercraft and motorized boats would likely have long-term, minor, cumulative impacts to overall visitor use and experience of park resources. However, impacts to some park visitors who desire to experience park resources without conflict from motorized recreational uses, including PWC use, would continue at a moderate level over the long term.

Conclusion. Alternative A would result in few changes to visitor use because existing use patterns would continue. There would be no impact to those continuing to use personal watercraft while visiting the preserve to experience park resources and values. For other visitors, especially anglers

who desire to experience park resources and values without conflict from PWC users in early morning hours, there would be minor to moderate, long-term impacts since these uses would continue.

The continued use of personal watercraft and motorized boats would likely have long-term, minor, cumulative impacts to overall visitor use and experience of park resources. However, impacts to some park visitors who desire to experience park resources without conflict from motorized recreational uses, including personal watercraft, would continue at a moderate level over the long term.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. No longer allowing PWC use in backwater areas and limiting times of use would affect those visitors who come to the preserve to experience park resources and values on their craft. However, because PWC users already avoid these areas and generally do not use personal watercraft in the early morning or late afternoon, adverse impacts would be minor. PWC owners of two-stroke engines would eventually be banned from the area, and the impacts to those individuals would be considered minor to moderate; however, use of the river by other means would not be precluded. For those visitors who enjoy fishing and other quiet activities, there would be a beneficial impact because potential conflicts between PWC use and other visitors would be reduced. Educational materials under this alternative would explain restrictions, helping avoid conflicts and enhancing visitor experiences. Overall visitor satisfaction would likely remain the same in the long term, with short-term, somewhat minor, adverse impacts while PWC users were adapting to the new rules.

Cumulative Impacts. Cumulative impacts would be essentially the same as those described for alternative A, with reduced incremental impacts from PWC use to anglers, backwater users, and others who pursue more passive experiences while visiting the preserve. Cumulative impacts overall would be negligible to minor.

Conclusion. No longer allowing PWC use in backwater areas and limiting times of use would affect those visitors who come to the preserve to experience park resources and values on their personal watercraft. However, because most PWC users already avoid these areas and generally ride their craft later in the day, adverse impacts would be minor. PWC owners of non-compliant two-stroke engines would eventually be banned from the area, and the impacts to those individuals would be minor to moderate; however, use of the river by other means would not be precluded. For those visitors who enjoy fishing and other quiet activities, there would be a beneficial impact because potential conflicts between PWC use and other visitors would be reduced.

Cumulative impacts would be essentially the same as those described for alternative A, with reduced incremental impacts from PWC use to anglers, backwater users, and others who pursue more passive experiences while visiting the preserve. Cumulative impacts overall would be minor.

Impacts of the No-Action Alternative

Analysis. PWC use would no longer be permitted within the preserve, which would be a minor to moderate impact to those visitors using this form of recreation to experience park resources and values. Given the relatively low level of use (12 users on an average day), and the availability of nearby waters in which PWC use would continue, impact to overall park visitation would be minor. For those who visit the preserve to experience its resources and values in more passive ways (e.g.,

fishing, nonmotorized uses), there would be a long-term, beneficial impact since conflicts between PWC use and these other uses would be eliminated.

Cumulative Impacts. Other motorized boating would continue in the preserve, with the exception of PWC use. Given the low numbers of personal watercraft that would be precluded from overall park visitation, impacts would be minor.

Conclusion. Minor to moderate impacts would occur to those visitors using personal watercraft to experience park resources and values. For those who visit the preserve to experience its resources and values in more passive ways (e.g., fishing, nonmotorized uses) there would be a long-term, beneficial impact since conflicts between PWC use and these other uses would be eliminated. Other motorized boating would continue in the preserve, with the exception of personal watercraft. Given the low volume of PWC use that would be precluded from overall park visitation, impacts would be minor.

VISITOR SAFETY

While no PWC accidents in Big Thicket have been reported, PWC speeds, wakes, and proximity to other users can pose conflicts and safety hazards. Collisions may result with nonmotorized boaters (canoeists, kayakers, etc.) or persons in the river (waders, swimmers, and submerged water recreationists), due to the limited line of sight in the lower Neches River and its tributaries.

GUIDING REGULATIONS AND POLICIES

The NPS policy regarding public health and safety is that the saving of human life will take precedence over all other management actions. The National Park Service and its concessioners, contractors, and cooperators are to provide a safe and healthful environment for visitors and employees. The National Park Service works cooperatively with other federal, state, and local agencies, organizations, and individuals to carry out this responsibility. However, national preserve visitors assume a certain degree of risk and responsibility for their own safety when visiting areas that are managed and maintained as natural, cultural, or recreational environments (NPS *Management Policies 2001,* sec. 8.2.5). The national preserve abides by all federal and state regulations that pertain to watercraft use in order to avoid visitor use conflicts, to protect the health and safety of visitors, and to protect visitor use and enjoyment of national preserve resources.

There are no local safety regulations for PWC use. State regulations that apply to personal watercraft are summarized in the "Affected Environment" chapter (see page 61).

METHODOLOGY AND ASSUMPTIONS

The methodology for visitor safety is similar to that used for visitor experience. The potential visitor-related impacts attributable to personal watercraft — higher rate of accidents than other watercraft and safety conflicts with other park users — could potentially affect the mandate to provide for injury-free visits.

It is assumed, as described in the "Affected Environment," that Texas PWC regulations are in place and enforced within the national preserve. These regulations govern the type of PWC activities near the shore, the distance that should be maintained between personal watercraft and the shoreline and other boats, the timing of PWC use, and the age and educational requirements of PWC operators.

Study Area

The study area includes surface waters and adjacent landing areas in the lower Neches River and the mouth of Pine Island Bayou, where PWC use is allowed.

Impact of PWC Use on Visitor Safety

The impact intensities for visitor safety follow. Where impacts to visitor safety become moderate, it is assumed that current visitor satisfaction and safety levels would begin to decline and some of the preserve's long-term visitor goals would not be achieved.

Negligible: The impact to visitor safety would not be measurable or perceptible.

Minor: The impact to visitor safety would be measurable or perceptible, but it would be limited to a relatively small number of visitors at localized areas. Impacts to visitor safety might be realized through a minor increase in the potential for visitor conflicts in current accident areas.

Moderate: The impact to visitor safety would be sufficient to cause a change in accident rates at existing low-accident locations or create the potential for additional visitor conflicts in areas that currently do not exhibit noticeable accident trends.

Major: The impact to visitor safety would be substantial. Accident rates in areas usually limited to low-accident potential are expected to substantially increase in the short and long term.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. PWC use would continue at about current levels in the area where it is currently permitted under alternative A, with an average of approximately 12 personal watercraft within the study area during high-use days. The primary area for potential PWC collisions or other conflicts is with anglers and swimmers along the main river channel. However, there were no PWC-related accidents or fatalities from 1995 to 2000, which indicates that the existing conditions are relatively safe with regard to PWC use. There are areas of limited sight distance along the main channel, but no accidents have been reported there. Therefore, impacts with regards to visitor safety would be negligible.

Cumulative Impacts. In addition to PWC use, the safety of visitors in the lower Neches River corridor may be compromised by many other activities occurring in the preserve, such as boating, swimming, and water-skiing. All of these activities have risks associated with them, especially if alcohol is consumed. Also, visitor safety is affected by exposure to the natural dangers of the park, such as alligators, snakes, and insects.

Preserve managers take many precautions to prevent accidents and injuries and do not allow visitors into unsafe areas, such as construction zones. Also, the staff patrol the river and issue warnings to those who are jeopardizing the safety of others or causing conflicts. Therefore, potential cumulative impacts related to visitor safety would be negligible to minor.

Conclusion. Alternative A would result in negligible impacts to visitor safety because the existing, relatively safe conditions associated with low levels of PWC use would continue. This alternative would pose some safety risks because all existing recreational uses would continue. This threat,

however, is considered negligible, because safety records over the last five years indicate that there have been no PWC-related accidents, and the low level of use is expected to continue over the years.

Cumulative impacts would be negligible to minor.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Alternative B would slightly improve the safety conditions along the lower Neches River since PWC use would be restricted to after sunrise, primarily to avoid visitor conflicts with anglers in the early morning hours. Restricting PWC use in backwater areas would also reduce conflicts with fishing boats in those areas. Overall, this alternative would have a beneficial impact simply be reducing the potential for accidents. Educational materials distributed under this alternative would help enforce the need to minimize conflicts and to avoid alcohol use while operating any vessel.

Cumulative Impacts. Cumulatively, there would be some beneficial impacts due to the safety information provided in the educational materials, which would help all visitors increase attention to safety issues. Otherwise, cumulative impacts would be somewhat beneficial, since this alternative would provide for the separation of PWC use from many other potential conflicts in backwater areas and during certain hours.

Conclusion. Overall, this alternative would have a beneficial impact simply by reducing the potential for accidents. Safety would be enhanced to a minor degree because of restrictions that would reduce the number of personal watercraft on the river at certain times, that would prohibit PWC use in backwater areas, and that would provide educational materials.

Cumulative impacts would be similar to, but slightly reduced from, alternative A.

Impacts of the No-Action Alternative

Analysis. Discontinuing PWC use within the preserve would benefit visitor safety by eliminating the potential for PWC accidents and conflicts with other park visitors.

Cumulative Impacts. Cumulative impacts would be beneficial because PWC use would be eliminated, but other uses would continue to affect overall visitor safety to a minor degree.

Conclusion. The no-action alternative would result in beneficial impacts to visitor safety since personal watercraft would no longer be allowed to operate in the preserve.

Eliminating personal watercraft would reduce the potential for PWC-related accidents, although cumulative impacts from other uses would affect visitor safety to a minor degree.

CULTURAL RESOURCES

Guiding Regulations and Policies

In addition to laws that generally affect the management of cultural resources, such as the NPS Organic Act and the National Environmental Policy Act, the following laws and policies establish how cultural resources must be managed.

The Antiquities Act of 1906 (P.L. 209) authorizes the president to establish historic landmarks and structures as monuments owned or controlled by the U.S. government and instituted a fine for unauthorized collection of their artifacts.

The National Historic Preservation Act of 1966 (16 USC 470, et seq.) requires that federal agencies with direct or indirect jurisdiction over undertakings take into account the effect of those undertakings on properties that are listed on, or eligible for listing on, the National Register of Historic Places (section 106). Section 110 requires that programs be established in consultation with the states to identify, evaluate, and nominate properties to the national register.

The Archeological Resources Protection Act of 1979 (16 USC 470aa et seq.) seeks to further protect and preserve archeological resources on public lands.

The Native American Graves Protection and Repatriation Act of 1990 (25 USC 3001) sets forth procedures for determining the final disposition of any human remains, funerary objects, or objects of cultural patrimony that are discovered on public lands or during the course of a federal undertaking.

Applicable agency policies relevant to cultural resources include chapter 5 of NPS *Management Policies 2001* and *Director's Order #28: Cultural Resource Management Guideline*.

Assumptions and Methodologies

Potential impacts to cultural resources have been evaluated based on the extent of known cultural resources in the area of PWC use.

In accordance with section 106 of the National Historic Preservation Act, only those cultural resources that are eligible for listing or are listed on the National Register of Historic Places are considered federally protected resources and are the subject of this impact analysis. An impact, or effect, to a cultural property occurs if a proposed action would alter in any way the characteristics that qualify the property for inclusion or potential listing on the national register. If the proposed action would diminish the integrity of any of these characteristics, it is considered to be an adverse effect.

Study Area

For this impact analysis, the area of PWC use has been defined as the waterways along the lower Neches River, including some backwater areas, and conservatively up to 100 feet inland, where PWC users may walk or gather in groups.

Impact to Cultural Resources from PWC Use and Access to Sites

In order to evaluate the alternatives, the following criteria have been established to define the level of impacts to cultural resources:

Negligible: There would be no direct or indirect impacts to any property potentially eligible for or listed on the National Register of Historic Places.

Minor: Direct or indirect impacts to a property potentially eligible for or listed on the National Register of Historic Places would be anticipated; however, these effects would be minor in number, extent, and/or duration. Minor impacts, for example, could include temporary disturbances (such as indirect noise from construction activities) that would not alter the character for which the property has been listed, and the site would be returned to its original state following the action.

Moderate: Direct or indirect impacts to a property potentially eligible for or listed on the National Register of Historic Places are anticipated, and these effects would be greater in number, extent, and/or duration than minor impacts. Moderate impacts, for example, could include disturbances (such as the long-term physical alteration of a site that would require mitigation through data recovery techniques) that could alter the character for which the property has been listed, and the site might not resume its original state following the action.

Major: Direct or indirect impacts to a property potentially eligible for or listed on the National Register of Historic Places would be anticipated, and these effects would be more substantial in number, extent, and/or duration than moderate impacts. Major impacts could result in the alteration of the character for which the property has been listed, thus potentially disqualifying the property from remaining on the national register. Examples of major impacts include isolation of a property from or alteration of the character of a property's setting, including removal from its historic location; the introduction of visual, audible, or atmospheric elements that are out of character with the property or that alter its setting; and neglect of a property resulting in its deterioration or destruction (36 CFR 800.5).

If it is determined there is potential for impacts to cultural resources listed on or eligible for listing on the National Register of Historic Places, the National Park Service will coordinate with the Texas State Historic Preservation Office to determine the level of effect to the property and any appropriate mitigation measures that need to be taken. An official determination of effect will be issued by the state officer that documents the level of impact to the resource, including any potential for impairment to cultural resources, and the course of action that the National Park Service will be required to perform to mitigate these effects.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. PWC use would continue within the study area under alternative A. The inventory of cultural resources in Big Thicket National Preserve is not complete, so a PWC user could find artifacts or remnants of a cultural site. However, there are no known historic, archeological, or Native American properties in the areas where personal watercraft are used. Also, PWC use areas are located along a floodplain, which is typically considered a low probability area for cultural resources because river dynamics have likely already disturbed cultural sites. Inland areas are rarely accessed by PWC users due to biological barriers such as mosquitoes, snakes, and thick vegetation found along the river banks. Therefore, impacts to cultural resources would likely be negligible under alternative A. In the event that unanticipated cultural resources were discovered or exposed, the National Park Service

would identify and evaluate the resource according to relevant historic preservation regulations and NPS policies.

Cumulative Impacts. All recreational activities and development actions in the preserve, including any ground-disturbing activities (such as oil and gas exploration) have the potential to disturb cultural resources. The preserve currently maintains a cultural resources inventory and evaluates the potential for cultural resources at every potential development site before construction. Therefore, it is not likely that cultural resources would be disturbed. In the event that unanticipated cultural resources were discovered or exposed, the National Park Service would identify and evaluate the resource according to relevant historic preservation regulations and NPS policies. It is possible for cultural resources in the preserve to be affected by other visitors from trampling or other disturbance, potentially resulting in minor to moderate impacts to these resources. Therefore, the negligible impacts of alternative A related to PWC use, in combination with the existing potential impacts from visitor use throughout the preserve, could result in cumulative minor to moderate impacts on cultural resources.

Conclusion. Alternative A would result in negligible impacts to cultural resources. Although the potential for finding cultural resources in the area of PWC use is already small, there is a slightly increased possibility of visitors discovering or harming cultural resources due to the continued use of the area by PWC recreationists.

Because of impacts related to other park users, cumulative impacts would be minor to moderate.

Alternative A would not result in impairment to cultural resources.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Impacts under alternative B would be the same as those described for alternative A, except that the possibility of finding or disturbing a cultural resource within the study area would be reduced as a result of restrictions placed on the use of backwater areas. Impacts to cultural resources under alternative B would be negligible. In the event that unanticipated cultural resources were discovered or exposed, NPS staff would identify and evaluate the resource according to relevant historic preservation regulations and NPS policies.

Cumulative Impacts. The negligible impacts of alternative B, in combination with the existing potential impacts from visitor use, could result in cumulative minor to moderate impacts on cultural resources except there would be a reduced possibility of finding or disturbing a site in the backwater areas. However, it is possible for cultural resources in the preserve to be affected by other visitors from trampling or other disturbance, potentially resulting in minor to moderate impacts to these resources.

Conclusion. Although the potential for finding cultural resources in the study area is small, alternative B would have a slightly decreased possibility of visitors discovering or disturbing cultural resources in backwater areas. Alternative B would result in negligible impacts to cultural resources, as described for alternative A.

Cumulative impacts would be minor to moderate, based on the negligible impacts of alternative B combined with other park users in potentially culturally sensitive areas.

Alternative B would not result in impairment to cultural resources.

Impacts of the No-Action Alternative

Analysis. The chance of PWC users potentially affecting unknown cultural resources directly or indirectly discovering, disturbing, or otherwise affecting a cultural property would be eliminated.

Cumulative Impacts. PWC contributions to cumulative impacts would be eliminated, however, other ongoing activities would affect cultural resources to a minor to moderate degree.

Conclusion. Banning PWC use would further limit the potential for cultural resource discovery or disturbance by visitors.

Cumulative impacts would be minor to moderate from other park users in potentially culturally sensitive areas. The incremental contribution of PWC use to cumulative effects on cultural resources would be eliminated.

The no-action alternative would not result in impairment to cultural resources.

SOCIOECONOMIC EFFECTS

This section summarizes the socioeconomic impacts associated with the proposed regulatory alternatives for PWC use in Big Thicket National Preserve. A detailed description of these impacts and a complete list of references is provided in "Economic Analysis of Personal Watercraft Regulations in Big Thicket National Preserve" (Law Engineering and Environmental Sciences, et al. 2001). A benefit-cost analysis of the alternatives is also included.

Economic Impact Analysis

Big Thicket National Preserve experiences relatively low rates of PWC visitation. According to local PWC dealerships, PWC users prefer alternative destinations such as Sibean Lake just south of the preserve. According to NPS staff at the preserve, approximately 600 personal watercraft use the preserve annually, accounting for about 5% to 10% of all watercraft used here. Almost all of the PWC users in the preserve are believed to be local residents using their personal machines. No PWC rental shops were identified in the vicinity of Big Thicket, and the businesses that sell personal watercraft in the area have indicated that the great majority of their sales are to local residents. This implies that recreational PWC use is not the primary reason people visit the preserve.

As mentioned above, local PWC dealerships have stated that the majority of PWC use occurs in nearby areas outside the national preserve. Thus, it is expected that local residents owning personal watercraft who are no longer willing or able to ride in the preserve following a change in regulations would likely shift most of their recreational PWC use to other locations within the region, resulting in little change in regional PWC use. Nonetheless, there was some concern among the PWC dealerships contacted that any restriction in PWC use would cause a reduction in sales. Of the three dealerships contacted, one believed that the implementation of the no-action alternative (eliminating PWC use within the preserve) would likely result in a decline in his PWC sales and service, one expected no impact, and one was uncertain whether his business would be affected.

Although PWC sales for local dealerships may decline somewhat, a decline in visits to the national preserve would be unlikely to appreciably affect lodging establishments, restaurants, or other local businesses. Given that PWC use in Big Thicket is primarily by local residents using their own

machines, and other recreational PWC opportunities exist within the area, measurable impacts on the regional economy or the communities in which these businesses are located are anticipated for any of the management alternatives evaluated in this document.

Benefit-Cost Analysis

The purpose of benefit-cost analysis is to determine whether a proposed action (in this case, the regulation of PWC use in Big Thicket) would promote an efficient allocation of resources. The analysis is used to assess whether the proposed action would generate more benefits than costs. These costs and benefits would accrue directly to households that use personal watercraft, and indirectly to those who are affected by PWC use (e.g., those who would benefit from reduced noise). The resulting changes in PWC use might also impose costs on those who own or work for PWC-related businesses.

Even individuals who are not active visitors to Big Thicket can benefit from the knowledge that preserve resources are being protected and preserved. These values can stem from a desire to ensure the enjoyment of resources by others (both current and future generations) or from a sense that these resources have intrinsic value. Evidence of the value for resources like those at Big Thicket has been established in the economic literature. Restrictions on PWC use at Big Thicket could therefore provide benefits to both users and nonusers in a number of ways by protecting the preserve's ecological resources.

For purposes of this analysis, six major affected groups have been identified and listed in Table 23, along with the anticipated impacts of the proposed regulatory alternatives on social welfare. The following definitions apply:

> *Consumer surplus* — the economic measure of net benefits that accrue to individuals from PWC use and the appreciation of Big Thicket resources.
>
> *Producer surplus* — the economic measure of net benefits that accrue to businesses that sell or rent personal watercraft and other related businesses. Producer surplus is generally equivalent to business profit.

Increases in consumer surplus and producer surplus represent benefits, while decreases in those measures represent costs.

TABLE 23: IMPACT OF ALTERNATIVES ON USER GROUPS

User Group	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
PWC Users	No change in consumer surplus.	Consumer surplus is expected to decrease as a result of timing and spatial restrictions on PWC use in the preserve, and the requirement to use four-stroke engines by 2012.	Total loss of consumer surplus to users in the preserve as a result of a PWC ban.
Other Visitors or Potential Visitors (Canoeists, anglers, other boaters, swimmers, hikers, and other visitors)	No change in consumer surplus.	Consumer surplus is expected to increase slightly for current users as a result of increased solitude in backwater areas, increased water quality in backwater areas, timing restrictions on PWC use, and a decrease in the risk of accidents involving personal watercraft.	Increases in consumer surplus would be similar to, but larger than, benefits realized under alternative B.

User Group	Alternative A — Continue PWC Use as Currently Managed under a Special Regulation	Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors	No-Action Alternative
		Consumer surplus is expected to increase for new visitors who would not have visited Big Thicket if there were no PWC restrictions.	
Producers of PWC Services (PWC rental shops, PWC sales shops, and other parts of the local economy providing PWC-related services)	No change in producer surplus.	No PWC rental shops were identified in the vicinity of Big Thicket. Producer surplus might decrease somewhat for PWC dealers as a result of a slight decline in PWC-related sales and servicing. Other parts of the local economy, such as hotels, restaurants, and gas stations, are not expected to have a significant decrease in producer surplus.	No PWC rental shops were identified in the vicinity of Big Thicket. Producer surplus might decrease somewhat for PWC dealers as a result of a slight decline in PWC-related sales and servicing; the decrease could be slightly greater than under alternative B. Other parts of the local economy, such as hotels, restaurants, and gas stations, are not expected to have a significant decrease in producer surplus.
Local Residents of the Surrounding Area	No change.	Local residents would not experience a measurable decrease in welfare as a result of impacts on traffic and congestion in the community as a result of PWC restrictions within the national preserve. Some residents whose property is adjacent to the preserve might experience a decline in welfare if they were unable to access the preserve or surrounding waters on personal watercraft, and others might experience an increase in welfare from reduced noise.	Local residents would not experience a measurable decrease in welfare as a result of impacts on traffic and congestion in the community as a result of banning PWC use within the national preserve. Some residents whose property is adjacent to the preserve might experience a decline in welfare because they would be unable to access the preserve or surrounding waters on personal watercraft, and others might experience an increase in welfare from reduced noise.
Producers of Services for Preserve Visitors Who Do Not Use Personal Watercraft	No change in producer surplus.	Producer surplus might increase if PWC restrictions resulted in an increase in demand for angling, canoeing, and other activities in the preserve and the provision of services related to these activities.	The increase in producer surplus is not expected to be significantly greater than that realized under alternative B.
General Public	No change in welfare.	The general public might experience an increase in welfare from increased environmental quality in the preserve.	The increase in welfare is not expected to be significantly greater than that realized under alternative B.

This analysis is qualitative since quantification was not feasible with currently available data. The primary beneficiaries of alternatives A and B would be visitors who do not use personal watercraft and whose park experience is negatively affected by the presence of such watercraft. Among the more popular other activities and means of experiencing the preserve are canoeing, fishing, boating, and hiking. In 2000 the number of recreational visits to the preserve was roughly 60,000, 99% of which were non-PWC users.

Benefits to the general public, or those who do not visit Big Thicket, are also likely to result from the proposed measures, especially in light of the preserve's status as an international biosphere reserve. For example, these individuals could benefit simply from the knowledge that the preserve's natural resources are being protected. Therefore, some of the benefit categories (aesthetic, human health,

ecosystem protection) might accrue in the form of nonuse values. The importance of recognizing these values is affirmed in the NPS Organic Act, which includes providing for the enjoyment of park resources and values, and which applies to all people, not just those who visit a national park system area. Furthermore, through the Redwood National Park Expansion Act of 1978, Congress has provided that when there is a conflict between conserving national park resources and values and providing for the enjoyment of them, conservation is to be the primary concern. Overall, impacts to nonuse values from the three PWC management alternatives would be negligible to minor.

Costs to PWC Users

Two groups of PWC users may be affected by alternative B and the no-action alternative: (1) PWC users who currently ride in Big Thicket, and (2) those who ride in other areas outside the national preserve, where users displaced from the preserve might decide to ride if PWC use was restricted or eliminated in Big Thicket. For PWC users who currently ride in the national preserve or who may want to ride there in the future, alternative B and the no-action alternative could result in consumer surplus losses. However, to the extent that individuals consider other PWC areas close substitutes to what is available in Big Thicket, the loss in consumer surplus associated with restricting or eliminating PWC use would be lower. PWC users who currently ride in nearby areas where users displaced from Big Thicket might visit would lose some consumer surplus if these areas subsequently became more crowded. This is highly unlikely since 20–40 PWC users are present in Big Thicket or would be expected on a high-use day.

Some landowners with properties adjacent to or near the preserve in areas that would be off limits under alternative B and the no-action alternative might be affected because they might no longer be able to use personal watercraft to access the national preserve from their property or to travel to other destinations on personal watercraft through Big Thicket. These users would lose consumer surplus if they were forced to access Big Thicket waters from other public or private boat ramps or if they decided not to ride as a result of the restrictions.

Costs to the Local Area Businesses

If PWC use decreased, then PWC-related suppliers and rental services could be affected. In addition, lodging establishments, restaurants, gas stations, and other businesses that serve PWC users could experience a reduction in business. Three firms that sell personal watercraft were identified in the region and no rental shops. To provide a quantitative estimate of lost producer surplus resulting from the proposed regulations, estimates of PWC sales revenue were obtained from personal interview with the businesses. The estimated annual range of lost producer surplus for sales shops is presented below:

Alternative A:	$0 loss
Alternative B:	$70 to $520 loss
No-Action Alternative:	$680 to $7,760 loss

PWC users in Big Thicket are believed to be primarily local residents on day trips. Lodging establishments, restaurants, gas stations, and other businesses that serve PWC users are not likely to experience a reduction in business under any of the alternatives.

PRESERVE MANAGEMENT AND OPERATIONS

Conflict with State and Local Ordinances and Policies Regarding PWC Use

Some states and local governments have taken action, or are considering taking action, to limit, ban, and otherwise manage PWC use. While a national park system unit may be exempt from these local actions, consistency with state and local plans must be evaluated in accordance with the National Environmental Policy Act.

Impacts related to conflicts with state and local ordinances have been analyzed qualitatively using professional judgment to define thresholds or impact magnitude.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. PWC users at Big Thicket under current conditions are required to follow all applicable state regulations regarding PWC use, as well as NPS regulations. State watercraft regulations are summarized in the "Affected Environment" chapter of this document (see page 61). There are no conflicts between park regulations and other regulations. The park rangers would continue to enforce all state regulations, plus the limitations in the Superintendent's Compendium. There are no local ordinances regarding PWC use. Impacts to alternative A related to conflict with state or local PWC regulations or policies would therefore be negligible.

Cumulative Impacts. No conflicts with state or local or other regional regulations or policies are anticipated with the continuation of PWC use under alternative A. PWC use would likely continue in the same manner in the preserve and in surrounding recreational areas, resulting in negligible impacts.

Conclusion. Continuing PWC use under alternative A would not result in conflict with state PWC regulations or policies, and there are no local regulations. Therefore, impacts (including cumulative impacts) related to such conflicts would be negligible.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. Under alternative B new restrictions on PWC use would be implemented by prohibiting use of backwater areas, limiting the time of use (in early morning and late afternoon), and phasing in requirements to use only four-stroke engines. These restrictions are within the National Park Service's right to regulate activities that can adversely affect resources within a park unit. The additional restrictions would be more restrictive than state PWC regulations, which already have a daylight-only limit on PWC use, but they would not conflict with state provisions or jurisdiction. The engine type phase-in requirement would be more restrictive than what would occur under EPA requirements (US EPA 1996a, 1997), but there would be no reason why preserve managers could not adopt a faster schedule for four-stroke engines. Therefore, impacts related to conflicts with state or local requirements or policies would be negligible.

Cumulative Impacts. No conflicts with state or local or other regional regulations or policies would be anticipated from implementing additional restrictions under alternative B. The restrictions would apply to the preserve only, and any impacts related to conflicts with other regulations would be non-existent or negligible.

Conclusion. Any changes in PWC regulations under alternative B would not result in conflicts with state PWC regulations or policies, and there are no local regulations. New rules set in place under alternative B would be slightly more restrictive to PWC users compared to other recreational areas in the state, but any conflict (including cumulative impacts) would be negligible.

Impacts of the No-Action Alternative

Analysis. The no-action alternative would result in a ban on PWC use in the national preserve. Because preserve managers have the right to regulate the types of activities that take place, and because there are no provisions in state PWC regulations forbidding additional controls or bans, there would be no conflicts. Impacts related to conflicts with other regulations or policies would be non-existent or negligible.

Cumulative Impacts. All the areas where PWC use occurs in the general region around the preserve are subject to the same state PWC regulations. Some areas may also have their own policies or requirements, or follow local requirements. While not all of the regional regulations are known, PWC use has not been banned in regional reservoirs. A PWC ban within Big Thicket National Preserve would not create conflicts with other areas that support PWC use or increase any known conflicts with such requirements. Cumulative impacts relating to such conflicts would be negligible.

Conclusion. Discontinuing PWC use would not result in conflict with state PWC regulations or policies, and there are no local PWC regulations. Therefore, impacts related to such conflicts (including cumulative impacts) would be negligible.

Impact to Preserve Operations from Increased Enforcement Needs

Impacts to park operations from increased enforcement needs have been analyzed qualitatively using professional judgment to define thresholds or impact magnitude.

Impacts of Alternative A — Continue PWC Use as Currently Managed under a Special Regulation

Analysis. Under Alternative A rangers would continue to patrol the area of the lower Neches River and Pine Island Bayou and enforce regulations of the preserve and the state relating to PWC use. There would be no increased enforcement needed or requested under alternative A, and impacts to park operations from increased enforcement needs would be negligible.

Cumulative Impacts. NPS staff provide enforcement for all activities occurring within the preserve. During the time any development or activity is taking place, enforcement by park staff would likely be higher in the area of the activity to ensure visitor safety and compliance with regulations and policies. Cumulative impacts would be considered minor, given all the enforcement that currently occurs within the preserve.

Conclusion. Alternative A would have negligible impacts to preserve operations because PWC use is expected to remain relatively low and regulations relating to PWC use would continue to be enforced.

Impacts of Alternative B — Continue PWC Use under a Special Regulation, but Implement Additional Restrictions and Educate Visitors

Analysis. NPS staff would have additional duties under alternative B to implement and enforce PWC restrictions related to times and areas of use, as well as types of engines that would be allowed. Under current conditions rangers patrol the area of the lower Neches River and Pine Island Bayou and enforce NPS and state PWC regulations. Under alternative B additional time or more rangers would be needed to patrol backwater areas and to patrol during early morning and late afternoon hours. As the four-stroke engine requirement was phased in, staff would also need to look for violations of this requirement anywhere in the study area.

Extra staff time would also be needed initially to develop educational materials for distribution to the public. As the public would become more aware of the new restrictions, and educational material became available, enforcement and educational time would likely be reduced to approximately the current levels. Adverse impacts to preserve operations would be minor to moderate in the short term to minor over the long term as the public began to understand and comply with the new rules.

Cumulative Impacts. Additional enforcement time related to the restrictions under alternative B would add to the existing time needed for park operations and enforcement for all actions in the preserve. Cumulative impacts would be minor over time, since no additional enforcement needs that would require a great deal of staff time over the next 10 years have been identified, and the staffing needs related to PWC restrictions would decline as more visitors became aware of and complied with requirements.

Conclusion. Alternative B would have short-term, minor to moderate adverse impacts on preserve operations due to the additional duties that would be required by NPS staff to implement and enforce the new PWC regulations and to educate visitors.

Cumulative impacts would be minor, as more visitors became aware of the restrictions included in this alternative.

Impacts of the No-Action Alternative

Analysis. The amount of work for NPS staff with regard to enforcing PWC regulations, including monitoring use and issuing citations and warnings, would be eliminated. This would be beneficial impact since it would allow the park staff some additional time to concentrate on other park operations in the study area. It is possible that staff could have to devote extra time at least initially to monitor the area in order to ensure that personal watercraft were not being used. Over the long term impacts would be beneficial to park operations and enforcement.

Cumulative Impacts. For the lower Neches River in particular, banning personal watercraft would eventually provide the staff who patrol the river with more time to do other enforcement work; however, this effect is expected to be negligible since other uses would continue.

Conclusion. The no-action alternative would initially result in short-term, minor to moderate impacts from enforcement of the PWC ban. Over the long term slight beneficial impacts to national preserve operations could occur because staff would have additional time to focus on other activities.

Cumulative impacts would continue, but PWC contribution to these impacts would be eliminated.

UNAVOIDABLE ADVERSE IMPACTS

Unavoidable adverse impacts are impacts that cannot be avoided and cannot be mitigated, and therefore would remain throughout the duration of the action. Under any alternative there would be adverse cumulative impacts if there were sufficient emissions to reduce water quality such that standards or criteria would be exceeded. If monitoring indicated that any standard was being exceeded, the impact could be mitigated through the required use of four-stroke engines for both boats and personal watercraft.

There could be unavoidable adverse impacts on the experience of various visitors, depending on their desired experience in the preserve. In particular, PWC use could adversely visitors who find this activity annoying or disruptive of their personal visitor experiences while in the preserve. Under the no-action alternative there would be unavoidable adverse impacts to PWC users who could no longer participate in this activity in Big Thicket National Preserve.

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF THE ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

Impacts to water and air quality could be mitigated by requiring the use of four-stroke engines to reduce emissions. Consequently, there would be no loss in long-term availability or productivity under any of the alternatives considered.

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Irretrievable commitments of resources are those that can be reversed, that is, the commitment of a renewable resource or the short-term commitment of any resource. These include the commitment of water quality and air quality by allowing all mobile sources desiring to do so, including personal watercraft, to continue using the national preserve under alternatives A and B. The use of fossil fuels to power personal watercraft would be an irretrievable commitment of this resource; however, this use is minor.

CONSULTATION AND COORDINATION

At the initial scoping meeting for this project, NPS staff at Big Thicket decided to use a newsletter and press release to solicit public input. Based on past experience with this type of issue, the staff believed they would receive more response from a newsletter than from holding public meetings. The staff noted that some public input on PWC use has already been obtained from scoping that has already been completed for the general management plan and from several comments received on postcards. Also, the compendium that limited PWC use to certain areas of the river was distributed to the public, with little response.

A mailing list of constituency groups likely to be interested in this issue was compiled using the preserve's current mailing list. This list was formed by adding names to the general management plan mailing list; other people who have since sent in comments on postcards will be added to this list if their names are not already on it. Other interested groups that were added to the mailing list include additional boat and PWC dealers, regional PWC manufacturing representatives, property owners along the river, and local PWC rental companies.

Public comments received as a result of the new NPS rulemaking have provided both support for and against the use of personal watercraft at Big Thicket. As of April 28, 2001, a total of 212 letters were received. Of these, 20 letters (1 out of state, 19 from Texas) supported PWC use at Big Thicket and 192 letters (157 out of state, 35 from Texas) did not. The majority of letters that did not support PWC use were mass mailing postcards from outside Texas.

On November 11, 2001, a newsletter was released to the public and the above-mentioned interested groups. The newsletter included proposed PWC alternatives developed through internal scoping and previous public input. A total of 348 letters, e-mails, and facsimiles were received. Of these, 318 responses supported the no-action alternative, 17 responses supported alternative A, 2 responses supported alternative B, and 10 responses supported unrestricted PWC use. (The final letter requested to be added to the mailing list).

In accordance with the Endangered Species Act, the U.S. Fish and Wildlife Service was consulted about the presence of threatened, endangered, and candidate species, as well as species of concern within the area of PWC use in Big Thicket National Preserve. Their response of October 10, 2001, is included in appendix B.

Consultation with the Texas State Historic Preservation Office will be completed upon issuance of this environmental issessment to the public.

APPENDIX A: SUPERINTENDENT'S ORDERS

BIG THICKET NATIONAL PRESERVE

REVISED: APRIL 9, 2001

Approved by:

_____

Richard R. Peterson

Superintendent

PERSONAL WATERCRAFT

Due to public safety concerns and potential damage to national preserve resources, the use of personal watercraft is **PROHIBITED** on any waters within the boundaries of the preserve, except those listed below:

Main channel of the Neches River within the Beaumont Unit;

Main channel of the Neches River within the Lower Neches River Corridor Unit downstream from the mouth of Village Creek to the Lakeview Sandbar Day Use Area; and

Main channel of the Pine Island Bayou within the Beaumont Unit from its confluence with the Neches River upstream to the mouth of Cook's Lake.

APPENDIX B: CONSULTATION WITH THE U.S. FISH AND WILDLIFE SERVICE

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Division of Ecological Services
17629 El Camino Real #211
Houston, Texas 77058-3051
281/286-8282 / (FAX) 281/488-5882

October 10, 2001

Nancy Van Dyke
URS Corporation
8181 East Tufts Avenue
Denver, Colorado 80237

Dear Ms. Van Dyke:

This responds to your letter of August 24, 2001, requesting information on your project area. You are preparing an Environmental Assessment relating to the use of personal water craft in the river portion of the Neches River of the Big Thicket National Preserve (Lower Neches River Unit and Beaumont Unit), located in Hardin, Orange, and Jefferson Counties, Texas.

Please find enclosed county lists of threatened, endangered, and candidate species, and species of concern, that include the project area. The area of impact is a significant distance away from known locations of the **Texas trailing phlox**, an endangered species found in Hardin County. However, you should assess and discuss the proposed action regarding any possibility for increased human access and disturbance to known and potential phlox habitat. Texas Parks and Wildlife Department is involved in recovery efforts for the **paddlefish**, a species of concern that occurs within the project area. You should consult with TPWD to determine whether the proposed action will affect paddlefish populations in this and adjacent areas of impact. Our office does have concerns regarding potential impacts to this and other riverine species from the proposed action.

The Corps of Engineers is responsible for determining if jurisdictional wetlands occur in the impact area of a proposed project. The Galveston District Corps of Engineers can be contacted at 409/766-3941.

If you have any questions or if we can be of further assistance, please contact Kathy Nemec at 281/286-8282.

Sincerely,

For Frederick T. Werner
Assistant Project Leader, Clear Lake ES Field Office

Enclosure

COUNTY-BY-COUNTY LISTING
LISTED/CANDIDATE SPECIES AND SPECIES OF CONCERN WITHIN CLEAR LAKE OFFICE AREA OF RESPONSIBILITY
(MARCH 2001)

E = Federally listed as endangered
T = Federally listed as threatened
H = historical occurrence only
M = migrant only N = nesting activity W = winter concentration
*C = candidate species: sufficient information exists to support listing
*SOC = species of concern: further biological information is needed to resolve their conservation status
*Species which have no legal status and receive no protection under the Endangered Species Act. They are identified for project planning purposes only and to alert you to the possibility that they may be proposed for listing at some future time.

ANGELINA COUNTY		
T	BALD EAGLE (N) + (W)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
SOC	bog coneflower	*Rudbeckia scabrifolia*
SOC	Drummond's yellow-eyed grass	*Xyris drummondii*
SOC	rough-leaf yellow-eyed grass	*Xyris scabrifolia*
SOC	slender gay-feather	*Liatris tenuis*
SOC	Texas heelsplitter	*Potamilus amphichaenus*
C	LOUISIANA PINE SNAKE	*Pituophis melanoleucus ruthveni*
AUSTIN COUNTY		
E	HOUSTON TOAD	*Bufo houstonensis*
E	ATTWATER'S GREATER PRAIRIE-CHICKEN	*Tympanuchus cupido attwateri*
T	BALD EAGLE (M)	*Haliaeetus leucocephalus*
BRAZORIA COUNTY		
T	BALD EAGLE (N)	*Haliaeetus leucocephalus*
E	BROWN PELICAN (N)	*Pelecanus occidentalis*
T	PIPING PLOVER (W)	*Charadrius melodus*
T	GREEN SEA TURTLE	*Chelonia mydas*
E	KEMP'S RIDLEY SEA TURTLE	*Lepidochelys kempii*
T	LOGGERHEAD SEA TURTLE	*Caretta caretta*
SOC	Texas windmill-grass	*Chloris texensis*
SOC	Texas diamondback terrapin	*Malaclemys terrapin littoralis*
SOC	southeastern snowy plover	*Charadrius alexandrinus tenuirostris*
SOC	reddish egret	*Egretta rufescens*
CHAMBERS COUNTY		
T	BALD EAGLE (N)	*Haliaeetus leucocephalus*
E	BROWN PELICAN	*Pelecanus occidentalis*
T	PIPING PLOVER (W)	*Charadrius melodus*
T	GREEN SEA TURTLE	*Chelonia mydas*
E	KEMP'S RIDLEY SEA TURTLE	*Lepidochelys kempii*
T	LOGGERHEAD SEA TURTLE	*Caretta caretta*
SOC	Texas windmill-grass	*Chloris texensis*
SOC	Texas diamondback terrapin	*Malaclemys terrapin littoralis*
SOC	southeastern snowy plover	*Charadrius alexandrinus tenuirostris*

COLORADO COUNTY		
E	HOUSTON TOAD	*Bufo houstonensis*
E	ATTWATER'S GREATER PRAIRIE-CHICKEN	*Tympanuchus cupido attwateri*
T	BALD EAGLE (N) + (W)	*Haliaeetus leucocephalus*
FAYETTE COUNTY		
T	BALD EAGLE (N)	*Haliaeetus leucocephalus*
FORT BEND COUNTY		
E	PRAIRIE DAWN	*Hymenoxys texana*
T	BALD EAGLE (N)	*Haliaeetus leucocephalus*
GALVESTON COUNTY		
E	ATTWATER'S GREATER PRAIRIE-CHICKEN	*Tympanuchus cupido attwateri*
E	BROWN PELICAN	*Pelecanus occidentalis*
T	PIPING PLOVER (W)	*Charadrius melodus*
T	GREEN SEA TURTLE	*Chelonia mydas*
E	KEMP'S RIDLEY SEA TURTLE	*Lepidochelys kempii*
T	LOGGERHEAD SEA TURTLE	*Caretta caretta*
SOC	Texas windmill-grass	*Chloris texensis*
SOC	Houston machaeranthera	*Machaeranthera aurea*
SOC	Texas diamondback terrapin	*Malaclemys terrapin littoralis*
SOC	southeastern snowy plover	*Charadrius alexandrinus tenuirostris*
SOC	reddish egret	*Egretta rufescens*
HARDIN COUNTY		
E	TEXAS TRAILING PHLOX	*Phlox nivalis* var. *texensis*
T	BALD EAGLE (M)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
SOC	white firewheel (=white blanket-flower)	*Gaillardia aestivalis* var. *winkleri*
SOC	paddlefish	*Polyodon spathula*
HARRIS COUNTY		
E	PRAIRIE DAWN	*Hymenoxys texana*
T	BALD EAGLE (N) + (W)	*Haliaeetus leucocephalus*
SOC	Texas windmill-grass	*Chloris texensis*
SOC	Houston machaeranthera	*Machaeranthera aurea*
HOUSTON COUNTY		
T	BALD EAGLE (W)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
C	NECHES RIVER ROSE-MALLOW	*Hibiscus dasycalyx*
SOC	Texas heelsplitter	*Potamilus amphichaenus*
JASPER COUNTY		
E	NAVASOTA LADIES'-TRESSES	*Spiranthes parksii*
T	BALD EAGLE (N)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
SOC	bog coneflower	*Rudbeckia scabrifolia*
SOC	Drummond's yellow-eyed grass	*Xyris drummondii*
SOC	rough-leaf yellow-eyed grass	*Xyris scabrifolia*
SOC	slender gay-feather	*Liatris tenuis*
SOC	tiny bog-buttons	*Lachnocaulon digynum*
SOC	Texas heelsplitter	*Potamilus amphichaenus*
SOC	paddlefish	*Polyodon spathula*
C	LOUISIANA PINE SNAKE	*Pituophis melanoleucus ruthveni*

JEFFERSON COUNTY		
E	BROWN PELICAN	*Pelecanus occidentalis*
T	GREEN SEA TURTLE	*Chelonia mydas*
E	KEMP'S RIDLEY SEA TURTLE	*Lepidochelys kempii*
T	LOGGERHEAD SEA TURTLE	*Caretta caretta*
SOC	paddlefish	*Polyodon spathula*
LIBERTY COUNTY		
T	BALD EAGLE (N)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
SOC	paddlefish	*Polyodon spathula*
MATAGORDA COUNTY		
T	BALD EAGLE (N)	*Haliaeetus leucocephalus*
E	BROWN PELICAN (N)	*Pelecanus occidentalis*
T	PIPING PLOVER (W)	*Charadrius melodus*
T	GREEN SEA TURTLE	*Chelonia mydas*
E	KEMP'S RIDLEY SEA TURTLE	*Lepidochelys kempii*
T	LOGGERHEAD SEA TURTLE	*Caretta caretta*
SOC	Texas diamondback terrapin	*Malaclemys terrapin littoralis*
SOC	Texas horned lizard	*Phrynosoma cornutum*
SOC	southeastern snowy plover	*Charadrius alexandrinus tenuirostris*
SOC	reddish egret	*Egretta rufescens*
MONTGOMERY COUNTY		
T	BALD EAGLE (N) + (W)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
NACOGDOCHES COUNTY (Angelina National Forest only)		
T	BALD EAGLE (W) (N outside ANF)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
C	TEXAS GOLDEN GLADECRESS (introduced)	*Leavenworthia texana*
NEWTON COUNTY		
T	BALD EAGLE (N) + (W)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
T	LOUISIANA BLACK BEAR (H)	*Ursus americanus luteolus*
SOC	bog coneflower	*Rudbeckia scabrifolia*
SOC	Drummond's yellow-eyed grass	*Xyris drummondii*
SOC	rough-leaf yellow-eyed grass	*Xyris scabrifolia*
SOC	slender gay-feather	*Liatris tenuis*
SOC	tiny bog-buttons	*Lachnocaulon digynum*
SOC	paddlefish	*Polyodon spathula*
C	LOUISIANA PINE SNAKE	*Pituophis melanoleucus ruthveni*
ORANGE COUNTY		
T	BALD EAGLE (M)	*Haliaeetus leucocephalus*
SOC	paddlefish	*Polyodon spathula*
POLK COUNTY		
E	TEXAS TRAILING PHLOX	*Phlox nivalis* var. *texensis*
T	BALD EAGLE (N) + (W)	*Haliaeetus leucocephalus*
E	RED-COCKADED WOODPECKER	*Picoides borealis*
SOC	paddlefish	*Polyodon spathula*

APPENDIX C: APPROACH TO EVALUATING SURFACE WATER QUALITY IMPACTS

Objective

Using simplifying assumptions, estimate the minimum (threshold) volume of water in a reservoir or lake below which concentrations of gasoline constituents from personal watercraft or outboards would be potentially toxic to aquatic organisms or humans. Using the estimated threshold volumes, and applying knowledge about the characteristics of the receiving waterbody and the chemical in question, estimate if any areas within the waterbody of interest may present unacceptable risks to human health or the environment.

Overall Approach

Following are the basic steps in evaluating the degree of impact a waterbody (or portion of a waterbody) would experience based on an exceedance of water quality standards / toxicity benchmarks for PWC- and outboard-related contaminants.

1. Determine concentrations of polycyclic aromatic hydrocarbons (PAHs), benzene, and methyl tertiary-butyl ether (MTBE) in gasoline (convert from weight percent to mg/L, as needed) and PAHs in exhaust. The half-life of benzene in water is 5 hours at 25°C (Verschuren 1983; US EPA 2001).
2. Estimate loading of PAHs, benzene, and MTBE for various appropriate PWC-hour levels of use for one day (mg/day)
3. Find/estimate ecological and human health toxicity benchmarks (risk-based concentrations [RBCs]) (µg/L) for PAHs, benzene, and MTBE.
4. Divide the estimated loading for each constituent (µg) by a toxicity benchmark (µg/L) to determine the waterbody threshold volume (L) below which toxic effects may occur (convert liters to ac-ft).

Estimated reductions in hydrocarbon (HC) emissions from personal watercraft and outboards will be significantly reduced in the near future, based on regulations issued by the EPA and California Air Resources Board (see the estimated reductions beginning on page 70).

Assumptions and Constants

Several assumptions must be made in order to estimate waterbody threshold volumes for each HC evaluated. Each park should have park-specific information that can be used to modify these assumptions or to qualitatively assess impacts in light of park-specific conditions of mixing, stratification, etc. and the characteristics of the chemicals themselves. The assumptions are as follows:

- BTEX (benzene, toluene, ethyl benzene, and xylene) are volatile and do not stay in the water column for long periods of time. Because benzene is a recognized human carcinogen, it is retained for the example calculations below and should be considered in each environmental assessment or environmental impact statement (Verschuren 1983; US EPA 2001).

- MTBE volatilizes slightly and is soluble in water. MTBE may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.
- PAHs volatilize slightly (depending on structure and molecule size) and may adhere to sediment and settle out of the water column or float to the surface and be photo-oxidized. They may accumulate in water from day to day, but this is not factored into the calculation and should be considered qualitatively in the assessment.
- The toxicity of several PAHs increases (by several orders of magnitude) when the PAHs are exposed to sunlight. This was not incorporated because site-specific water transparency is not known, and should be discussed qualitatively.
- The threshold volume of water will mix vertically and aerially with contiguous waters to some extent, but the amount of this mixing will vary from park to park and location to location in the lake, reservoir, river, etc. Therefore, although the threshold volume calculation assumes no mixing with waters outside the "boundary" of the threshold volume of water, this should be discussed in the assessment after the threshold volume is calculated. The presence or absence of a thermocline should also be addressed.
- Volume of the waterbody, or portion thereof, is estimated by the area multiplied times the average depth.

In addition to these assumptions, several constants required to make the calculations were compiled from literature and agency announcements. Gasoline concentrations are provided for benzene, MTBE and those PAHs for which concentrations were available in the literature. Constants used are:

- Gasoline emission rate for two-stroke personal watercraft: 3 gal/hour at full throttle (California Air Resources Board 1998)
- Gasoline emission rate for two-stroke outboards: estimated at approximately the same as for personal watercraft for same or higher horsepower outboards (80–150 hp); approximately twice that of personal watercraft for small (e.g. 15 hp) outboards. (Note: Assume total hours of use for the various size boats/motors, and that smaller 15 hp motors that exhaust relatively more unburned fuel would probably be in use for a much smaller amount of time than the recreational speedboats and PWC). This estimate is based on data from Allen et al. 1998 (Fig. 5). It is noted that other studies may show different results, e.g. about the same emissions regardless of horsepower, or larger horsepower engines having more emissions than smaller engines (e.g., California Air Resources Board 2001); the approach selected represents only one reasonable estimate.
- 1 gallon = 3.78 liters
- Specific gravity of gasoline: 739 g/L
- 1 acre-foot = 1.234×10^6 L
- Concentration of benzo(a)pyrene (B[a]P) in gasoline: 2.8 mg/kg (or 2.07 mg/L) (Gustafson et al. 1997)
- Concentration of naphthalene in gasoline: 0.5% or 0.5 g/100 g (or 3,695 mg/L) (Gustafson et al. 1997)
- Concentration of 1-methyl naphthalene in gasoline: 0.78% or 0.78 g/100 g (or approx. 5,760 mg/L) (estimated from Gustafson et al. 1997)

- Concentration of benzene in gasoline: 2.5% or 2.5 g/100 g (or 1.85×10^4 mg/L) (Hamilton 1996)
- Concentration of MTBE in gasoline: 15% or 15 g/100 g (or approx. 1.10×10^5 mg/L) (Hamilton 1996). (Note: MTBE concentrations in gasoline vary from state to state. Many states do not add MTBE.)
- Estimated emission of B(a)P in exhaust: 1080 µg/hr (from White and Carroll, 1998, using weighted average B(a)P emissions from 2-cylinder, carbureted two-stroke liquid cooled snow mobile engine using gasoline and oil injected Arctic Extreme injection oil, 24-38:1 fuel:oil ratio. Weighted average based on percentage of time engine was in five modes of operation, from full throttle to idle).
- Estimated amount of B(a)P exhaust emissions retained in water phase = approximately 40% (based on value for B(a)P from Hare and Springier, quoted in North American Lake Management Society 2001).

Toxicity Benchmarks

A key part of the estimations is the water quality criterion, standard, or toxicological benchmark for each contaminant evaluated. There are no EPA water quality criteria for the protection of aquatic life for the PWC-related contaminants (US EPA 1999a). There are, however, a limited number of EPA criteria for the protection of human health (via ingestion of water and aquatic organisms). Chronic ecotoxicological and human health benchmarks for contaminants were acquired from various sources. Following are the toxicity benchmarks for the PAHs, benzene, and MTBE having gasoline concentration information:

Chemical	Ecological Benchmark (µg/L)	Source	Human Health Benchmark** (µg/L)	Source
Benzo(a)pyrene	0.014	Suter and Tsao 1996	0.0044	US EPA 1999a**
Naphthalene	62	Suter and Tsao 1996	--	--
1-methyl naphthalene	19–34*	USFWS 2000	--	--
Benzene	130	Suter and Tsao 1996	1.2	US EPA 1999a**
MTBE	57,000***	Wong et al. 2001	--****	--

* Based on LC_{50}s of 1900 and 3400 µg/L for dungeness crab and sheepshead minnow, respectively (34 µg/L used for freshwater calculations)

** Based on the consumption of water and fish.

***A draft water quality criteria document for MTBE for the protection of aquatic life is expected to be issued in early 2002. These criteria will be based, in part, on work performed by Mancini et al. 2002. A notice of intent was published in the *Federal Register* in October 1999 (64FR58409).

**** Toxicological information for MTBE is currently under review. There is no EPA human health benchmark, but California has established a public health goal of 13 µg/L, which is used in calculations below.

Example Calculations

Calculations of an example set of waterbody volume thresholds are provided below for the chemicals listed above together with their concentrations in gasoline and available toxicity benchmarks.

Loading to Water

Loadings of the five contaminants listed above are calculated for one day assuming 10 personal watercraft operate for four hours (40 PWC-hours), each discharging 11.34 L gasoline per hour and having concentrations in fuel or exhaust as listed.

Benzo(a)pyrene (from the fuel): 40 PWC-hrs × 11.34 L gas/hr × 2.07 mg/L = 939 mg

Benzo(a)pyrene (from the gas exhaust): 40 PWC-hrs × 1080 µg/hr × 1/1000mg/µg × 0.40 = 17 mg

Total B(a)P = 956 mg

Naphthalene: 40 PWC-hrs × 11.34 L gas/hr × 3695 mg/L = 1.68×10^6 mg

1-methyl naphthalene: 40 PWC-hrs × 11.34 L gas/hr × 5760 mg/L = 2.61×10^6 mg

Benzene: 40 PWC-hrs × 11.34 L gas/hr × 1.85×10^4 mg/L = 8.39×10^6 mg

MTBE: 40 PWC-hrs × 11.34 L gas/hr × 1.10×10^5 mg/L = 4.99×10^7 mg

Loadings of contaminants from two-stroke outboards should be estimated based on the estimated loading based on the horsepower of the outboards involved (see "Assumptions and Constants" above) and the estimated hours of use, based on the types of boats and the pattern of use observed.

Threshold Volumes

Threshold volumes of water (volume at which a PWC- or outboard-related contaminant would equal the thresholds listed above) are calculated by dividing the estimated loadings (mg of contaminant) for the number of operational hours (e.g., 40 PWC-hours) by the listed toxicity benchmark concentrations (µg/L) and correcting for units (1 mg = 10^3 µg):

Protection of Aquatic Organisms

Benzo(a)pyrene: 956 mg B(a)P × 10^3 µg/mg / 0.014 µg/L = 6.8×10^7 L or 55 ac-ft

Naphthalene: 1.68×10^6 mg naphthalene × 10^3 µg/mg / 62 µg/L = 2.71×10^7 L or 22 ac-ft

1-methyl naphthalene: 2.61×10^6 mg 1-methyl naphth. × 10^3 µg/mg / 34 µg/L = 7.77×10^7 L or 63 ac-ft

Benzene: 8.39×10^6 mg benzene × 10^3 µg/mg / 130 µg/L = 6.45×10^7 L or 52 ac-ft

MTBE: 4.99×10^7 mg MTBE × 10^3 µg/mg / 57,000 µg/L = 8.75×10^5 L or 0.71 ac-ft

Based on these estimates and assumptions, 1-methyl naphthalene appears to be the contaminant (of those analyzed) that would be the first to accumulate to concentrations potentially toxic to aquatic organisms (i.e., it requires more water [63 ac-ft] to dilute the contaminant loading to a concentration below the toxicity benchmark); however, the threshold volumes are very similar among 1-methyl naphthalene, benzo(a)pyrene, and benzene.

Protection of Human Health

Benzo(a)pyrene: 956 mg B(a)P × 10^3 µg/mg / 0.0044 µg/L = 2.17×10^8 L or 176 ac-ft

Benzene: 8.39×10^6 mg benzene × 10^3 µg/mg / 1.2 µg/L = 6.99×10^9 L or 5,670 ac-ft

Note: If CA public health goal of 13 µg/L used: *MTBE:* 4.99×10^7 mg MTBE × 10^3 µg/mg / 13 µg/L = 3.83×10^9 L or 3,110 ac-ft

The California public health goal for MTBE is a drinking water–based goal and is not directly comparable to the other criteria used in this analysis. However, it may be of interest, since MTBE does

not volatilize rapidly and is very soluble, and MTBE concentration could be an issue if the receiving body of water is used for drinking water purposes and MTBE is not treated. Using the numbers provided above, benzene would be the first PWC-related contaminant in these example calculations that would reach unacceptable levels in surface water; however, volatilization of benzene from water to air was not included in the calculation. MTBE would be the next contaminant to reach unacceptable concentrations.

As a result of the estimated reductions in HC emissions (from the unburned fuel) in response to EPA regulations (listed above), additional personal watercraft and/or outboards may be used in the parks without additional impacts to water quality. For example, based on the expected overall reductions from EPA (1996), up to 75% additional personal watercraft/ outboards may be used in a given area in 2025 without additional impacts to water quality over current levels. Effects on noise levels, physical disturbance, or hydrocarbon emissions that are products of combustion (e.g., B(a)P) may not be similarly ameliorated by the reduced emission regulations.

Application of Approach

Use of the approach described above for evaluating possible exceedance of standards or other benchmarks must be adapted to the unique scenarios presented by each park, PWC use, and waterbody being evaluated. State water quality standards (including the numeric standards and descriptive text) must be reviewed and applied, as appropriate.

Factors that would affect the concentration of the contaminants in water must be discussed in light of the park-specific conditions. These factors include varying formulations of gasoline (especially for MTBE); dilution due to mixing (e.g., influence of the thermocline), wind, currents, and flushing; plus loss of the chemical due to volatilization to the atmosphere (Henry's Law constants can help to predict volatilization to air; see Yaws et al. 1993); adsorption to sediments and organic particles in the water column (e.g., PAHs), oxidation, and biodegradation (breakdown by bacteria). Toxicity of phototoxic PAHs may be of concern in more clear waters, but not in very turbid waters.

The chemical composition of gasoline will vary by source of crude oil, refinery, and distillation batch. No two gasolines will have the exact same chemical composition. For example, B(a)P concentrations may range from 0.19 to 2.8 mg/kg, and benzene concentrations may range from 0 to 7% (2%–3% is typical). MTBE concentrations will vary from state to state and season to season, with concentrations ranging from 0% to 15%. The composition of gasoline exhaust is dependent on the chemical composition of the gasoline and engine operating conditions (i.e., temperature, rpms, and oxygen intake). If site-specific information is available on gasoline and exhaust constituents, they should be considered in the site-specific evaluation. If additional information on the toxicity of gasoline constituents (e.g., MTBE) become available, they should be considered in the site-specific evaluation.

Lastly, results of the studies included in the collection of papers entitled "Personal Watercraft Research Notebook" provided by the NPS staff, can be used to provide some framework for your analysis. The following table summarizes some of the results presented in various documents on the collection for benzene, benzo(a)pyrene, and MTBE.

Table C-1: Pollutant Concentrations Reported in Water

Pollutant	Source(s)	Levels Found:	
		"Lower Use" (e.g. open water, offshore locations; reduced motorized watercraft use)	"Higher Use" (e.g., nearshore, motorized watercraft activity high)
Benzene	*Lake Tahoe Motorized Watercraft Report;* several studies reported USGS Miller and Fiore U of CA	1. <0.032 µg/l 2. <=0.3 µg/l 3. <0.1 µg/l	1. 0.13 – 0.33 µg/l 2. just over 1 µg/l 3. 0.1 – 0.9 µg/l
PAHs	A. Mastran et al.	A. All below detection limits (<0.1 µg/l for pyrene and naphthalene; <2.5 µg/l for B(a)P, B(a)A, chrysene)	A. Total PAHs – up to 4.12 µg/l in water column; total PAHs - up to 18.86 µg/l in surface sample at marina, with naphthalene at 1µg/l; B(a)P – >=2.3 µg/l
	B. Oris et al.	B. Experiment #1 – 2.8 ng/l phototoxic PAHs	B. Experiment #1 – approx. 45 ng/l phototoxic PAHs; 5-70 ng/L total PAHs
MTBE	A. *Lake Tahoe Motorized Watercraft Report;* several studies reported		
	1. USGS	1. 0.11 – 0.51 µg/l	1. 0.3 – 4 2 µg/l
	2. Miller and Fiore	2. <=3 µg/l	2. 20 µg/l (up to approx. 31)
	3. U of CA	3. less than nearshore area	3. up to 3.77 µg/l
	4. U of Nevada – Fallen Leaf Lake	4. --	4. 0.7 – 1.5 µg/l
	5. Donner Lake (Reuter et al. 1998)	5. <0.1 µg/l	5. up to 12 µg/l Dramatic increase from 2 – to 12 µg/l over period from July 4 to 7)
	B. NPS, VanMouwerik and Hagemann 1999		
	6. Lake Perris	6. 8 µg/l (winter)	6. up to 25 µg/l
	7. Shasta Lake		7. 9-88 µg/l over Labor Day weekend
	8. 3-day Jet ski event		8. 50-60 µg/l
	9. Lake Tahoe		9. often within range of 20–25 µg/l, with max of 47 µg/l

GLOSSARY

deminimis — In the context of the Clean Air Act's general conformity requirements, deminimis levels are annual quantities of air pollutant emissions below which a federal action in a non-attainment or maintenance area is presumed to conform to a state's implementation plan without undergoing more rigorous air quality analysis or modeling.

isopleth — An imaginary line connecting points of equal magnitude.

maintenance area — A geographic region that at some time in the past was designated as a non-attainment area but has been redesignated through a formal rule-making process as being in attainment with the national ambient air quality standards. Maintenance areas continue to be monitored more rigorously than attainment areas and to be subject to controls to keep it in attainment with the national standards.

national ambient air quality standards (NAAQS) — Concentrations of criteria pollutants in ambient air (outdoor air to which the public may be exposed) below which it is safe for humans or other receptors to be permanently exposed. The Clean Air Act establishes two types of national air quality standards. **Primary standards** set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. **Secondary standards** set limits to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

The EPA Office of Air Quality Planning and Standards has set national ambient air quality standards for six principal pollutants, which are called "criteria" pollutants. They are listed below. Units of measure for the standards are parts per million (ppm) by volume, milligrams per cubic meter of air (mg/m^3), and micrograms per cubic meter of air ($\mu g/m^3$).

National Ambient Air Quality Standards

Pollutant	Standard Value*		Standard Type
Carbon Monoxide (CO)			
8-hour Average	9 ppm	(10 mg/m^3)	Primary
1-hour Average	35 ppm	(40 mg/m^3)	Primary
Nitrogen Dioxide (NO_2)			
Annual Arithmetic Mean	0.053 ppm	(100 $\mu g/m^3$)	Primary & Secondary
Ozone (O_3)			
1-hour Average	0.12 ppm	(235 $\mu g/m^3$)	Primary & Secondary
8-hour Average **	0.08 ppm	(157 $\mu g/m^3$)	Primary & Secondary
Lead (Pb)			
Quarterly Average	1.5 $\mu g/m^3$		Primary & Secondary
Particulate (PM_{10}) *Particles with diameters of 10 micrometers or less*			
Annual Arithmetic Mean	50 $\mu g/m^3$		Primary & Secondary
24-hour Average	150 $\mu g/m^3$		Primary & Secondary
Particulate ($PM_{2.5}$) *Particles with diameters of 2.5 micrometers or less*			
Annual Arithmetic Mean **	15 $\mu g/m^3$		Primary & Secondary
24-hour Average **	65 $\mu g/m^3$		Primary & Secondary
Sulfur Dioxide (SO_2)			
Annual Arithmetic Mean	0.03 ppm	(80 $\mu g/m^3$)	Primary
24-hour Average	0.14 ppm	(365 $\mu g/m^3$)	Primary
3-hour Average	0.50 ppm	(1300 $\mu g/m^3$)	Secondary

* Parenthetical value is an approximately equivalent concentration.

** The ozone 8-hour standard and the $PM_{2.5}$ standards are included for information only. A 1999 federal court ruling blocked implementation of these standards, which EPA proposed in 1997. EPA has asked the U.S. Supreme Court to reconsider that decision.

non-attainment area — A geographic region usually designated by an air quality planning authority through a formal rulemaking process within which one or more national ambient air quality standards are subject to violation. Sources of air pollutants in a non-attainment area are subject to more stringent requirements and controls than those in attainment areas (i.e., in areas where national standards are met).

NONROAD Model — An air quality emissions estimation model developed by the U.S. Environmental Protection Agency to estimate emissions from various spark-ignition type "nonroad" engines. The June 2000 draft of the NONROAD model was used to estimate air pollutant emissions from personal watercraft. It is available at <http://www.epa.gov/otaq/ nonrdmdl.html>.

personal watercraft (PWC) — As defined in 36 CFR section 1.4(a) (2000), refers to a vessel, usually less than 16 feet in length, which uses an inboard, internal combustion engine powering a water jet pump as its primary source of propulsion. The vessel is intended to be operated by a person or persons sitting, standing, or kneeling on the vessel, rather than within the confines of the hull. The length is measured from end to end over the deck excluding sheer, meaning a straight line measurement of the overall length from the foremost part of the vessel to the aftermost part of the vessel, measured parallel to the centerline. Bow sprits, bumpkins, rudders, outboard motor brackets, and similar fittings or attachments, are not included in the measurement. Length is stated in feet and inches.

SUM06 — The cumulation of instances when measured hourly average ozone concentrations equal or exceed 0.06 part per million (ppm) in a stated time period, expressed in ppm-hours

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CPFPWS	Coalition of Parents and Families for Personal Watercraft Safety
FFWCC	Florida Fish and Wildlife Conservation Commission
IWL	Izaak Walton League of America
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NTSB	National Transportation Safety Board
ODEQ	Oregon Department of Environmental Quality
PWIA	Personal Watercraft Industry Association
TNRCC	Texas Natural Resource Conservation Commission
USGS	U.S. Geological Survey

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Jessica T. Lau, Senior Environmental Scientist. B.A. Botany, M.A. Natural Science, B.S. Geology. Responsible for air quality analysis and technical review. Experience: Over 14 years in air quality, including various NEPA projects

Greg Sorensen, Technical Writer/Editor. B.A. International Affairs. Responsible for editing document. Experience: 27 years.

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As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historic places, and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people. The department also promotes the goals of the Take Pride in America campaign by encouraging stewardship and citizen responsibility for the public lands and promoting citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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