Kings Bay / Crystal River Springs Restoration Plan

Executive Summary
or more than a century, Florida has attracted new residents because of its moderate winter climate and natural beauty. This attractive environment has spurred urban and commercial development to support an expanding population. Additionally, agriculture has taken advantage of Florida’s temperate climate to produce quantities of food and forage, including row crops, livestock, and dairy goods. Increasing economic development has resulted in inevitable stresses on Florida’s natural environment as humans have altered the landscape to suit their needs. While the natural environment of Florida (for example the beaches, estuaries, rivers, and springs) are what attracted many people to the state in the first place, the inevitable environmental “footprint” of those residents and tourists has taken its toll on the state’s shrinking natural resources.

BACKGROUND

Kings Bay/Crystal River in Citrus County is one of Florida’s most outstanding spring-fed surface waters. Historically 70 artesian spring vents discharged more than 900 cubic feet per second (CFS) or 580 million gallons per day (MGD). Prior to the 1970s, Kings Bay was a fisherman’s and scuba diver’s paradise. Eelgrass covered the bottom of the bay like a lawn of unmowed waving grasses. Water clarity was so good that divers and fishermen could see fish, manatees, and other aquatic wildlife hundreds of feet away.

As the City of Crystal River grew around Kings Bay, real estate development led to excavation of numerous finger canals, providing dry ground for housing development and boating access for many of the new residents. The city began discharging treated, municipal wastewater with high nutrient concentrations directly to Kings Bay in 1962. By the 1970s, spring flows were noticeably declining due to increasing groundwater pumping throughout southwest Florida. Increasing nutrient contamination led to proliferation of exotic aquatic weeds, including hydrilla and water hyacinths. While Kings Bay’s water remained clear during this period, extreme measures, such as the addition of copper herbicides and sulfuric acid, were applied to kill off the plants that were interfering with recreational boating.

By the 1980s and 1990s, these poorly considered plant management measures had freed the bay from hyacinths and hydrilla dominance but had also largely led to the unintentional eradication of the desirable eelgrass. Spring flows continued to decline as the region’s population grew, bringing increased reliance on groundwater use for watering manicured landscapes and for farm irrigation. The result of declining spring flows, combined with elevated nutrients and the loss of much of the native aquatic vegetation in Kings Bay, was the proliferation of undesirable planktonic and benthic algae and a marked increase in salinity in the springs and bay. With these physical changes, water clarity in much of Kings Bay declined to less than 20 feet.
Whereas meaningful restoration of Kings Bay/Crystal River may appear to be complex, the causes of the problems are well understood, and corrective actions are feasible to implement. In other words, today’s residents and tourists visiting Kings Bay/Crystal River could live to see a restored and vibrant ecosystem. However, restoration can only result if everyone involved pulls together to make the relatively easy lifestyle changes that are needed to ensure success in restoring Kings Bay/Crystal River.

WHY SPRINGS ARE IMPORTANT

Springs and spring runs are a unique class of freshwater ecosystems. They differ from most fresh water aquatic environments in appreciable ways. Springs benefit from relatively constant inflows compared to the majority of streams and rivers. They exhibit high water clarity unlike most streams and rivers, with optimal light availability for primary productivity. And unimpacted springs have consistent chemistry and water temperature because of their reliance on groundwater inflows.

This unique combination of physical and chemical properties serves to optimize ecological efficiency and wildlife habitat in Florida’s springs and spring runs. Highly stable environmental conditions in healthy springs promote the evolution of complex, adapted plant and animal communities. The efficient use of available light by spring ecosystems translates into high productivity of fish and other wildlife. In addition to the importance of spring runs for the support of highly productive warm-water fisheries, and their support for other fresh water fauna such as turtles and water-dependent birds, they are critical for the life history of other large and economically-important migratory wildlife such as striped mullet and West Indian manatees.

North Florida is home to more than 1,000 artesian springs, the largest known concentration of springs in the world. All of these springs are threatened to a lesser or greater extent by human development activities within their groundwater contributing basins. The Howard T. Odum Florida Springs Institute has grouped Florida’s springs into 15 principal Springs Focus Areas that each include one or more major springs and their springsheds. The location and extent of the Springs Coast Focus Area is illustrated in Figure 1.

Figure 1. Approximate extent of 15 Florida Springs Restoration Focus Areas delineated by the Florida Springs Institute that are threatened by development pressures. The Springs Coast Focus Area is highlighted in red type.
SPRINGS COAST FOCUS AREA

The Springs Coast Focus Area includes portions of Citrus, Hernando, Pasco, and surrounding counties and is located along the west-central coast of peninsular Florida (Figure 2). This coastal area is primarily a zone of groundwater discharge. The porous limestone comprising the Upper Floridan Aquifer is the source of these springs, and groundwater discharge at these springs is from a regional system that encompasses an area of more than 2,400 square miles. The Springs Coast Focus Area contains four first-magnitude spring groups (springs that discharge more than 65 MGD) and many smaller springs. These springs historically discharged an average combined total of about 1,264 MGD of groundwater to coastal rivers, salt marshes, and swamps bordering the Gulf of Mexico.

The Springs Coast Focus Area is undergoing rapid growth, and groundwater resources are being actively developed for regional and local water supplies. Of greatest concern for this region are the quantity of coastal spring water that is being diverted to human uses, increasing contamination of spring flows with nitrate nitrogen (N), and the environmental impacts resulting from flow and water quality reductions to the freshwater and estuarine resources of the area.

The Springs Coast Focus Area is characterized by numerous sinkholes, internal drainage, and undulating topography typical of karst landscapes. The limestone comprising the Upper Floridan Aquifer has been extensively and repeatedly subjected to chemical dissolution and deposition processes in response to sea-level fluctuations.

Rainfall is the source of recharge for the Upper Floridan Aquifer. Recharge occurs as percolation through surface soils and by runoff into sinkholes. Surface drainage in the Springs Coast Focus Area is minimal, and most regional water movement is through the Upper Floridan Aquifer. The few perennial streams present are supplied almost entirely from spring discharge. Some perched water-table aquifers of limited extent are present locally in these sands. The surficial deposits, however, are generally too thin or clayey to compose an aquifer utilized for water supply.

THE KINGS BAY/CRYSTAL RIVER SPRINGS GROUP

Kings Bay/Crystal River is located in Citrus County approximately 60 miles north of Tampa, Florida (Figure 2). The bottom of Kings Bay is exposed limestone with a multitude of submarine springs and seeps. The land around Kings Bay is low and flat, with land-surface elevations averaging about 5 feet above sea level. Saltmarsh covers much of the area between Kings Bay and the Gulf of Mexico. The average depth in Kings Bay is about 8 feet, but the shallow tidal flats in the southwestern part of the bay are sometimes exposed at low tide, and one of the major spring vents south of Banana Island (Tarpon Spring) has a depth of about 65 feet. Water flow in Kings Bay is generally to the northwest, forming the headwaters of Crystal River, which flows about seven miles to the Gulf of Mexico. In the early 1960s, a network of 75-foot-wide canals was dredged along the eastern edge of the bay as part of waterfront residential development.

The first-magnitude spring system that forms the 600-acre Kings Bay embayment is the second largest spring system, as measured by discharge, in the state of Florida. Historic average spring flows were nearly 600 MGD and accounted for approximately 99 percent of the freshwater exiting Kings Bay through the Crystal River.

The Kings Bay/Crystal River springs support numerous protected wildlife species, including the West Indian manatee. With a mean annual water temperature range of 66°F to 76°F, Kings Bay forms the largest natural warm-water refuge for the endangered West Indian manatee in Florida. Accordingly, the unique ecological attributes of Kings Bay/Crystal River were recognized by the state of Florida in 1983 through its designation as an Outstanding Florida Water.
Figure 2. Florida’s “Springs Coast”, including all or parts of Levy, Marion, Citrus, Hernando, Hillsborough, Sumter, Lake, Pasco, and Polk Counties and illustrating the approximate extent of the springsheds for the four principal first-magnitude springs groups. Green lines indicate the pre-development potentiometric surface of the Floridan Aquifer in feet above mean sea level.
DESCRIPTIONS OF KEY SPRINGS

The approximate locations of 41 named and numbered spring complexes in Kings Bay are depicted in Figure 3. Brief descriptions are provided for six of the better known spring complexes.

HUNTERS SPRING
Hunters Spring, also known as American Legion Spring, is located in the northeastern portion of Kings Bay in Hunters Cove (No. 10, Figure 3). The spring is surrounded by a recreational park to the north and a residential area to the east and south. The spring vent is located within a designated swimming area about 40 feet offshore of the park. The spring is tidally affected. The average discharge rate for Hunters Spring measured in 2009 was 20 MGD.

HOUSE SPRING
House Spring is located at the head of the easternmost end of Hunters Cove (No. 8, Figure 3) within a seawall enclosure used as a swimming area. This multiple vent spring area is approximately 4 feet deep at the center of the swimming enclosure. Numerous other sand boils were also observed within this area. The average discharge rate measured for House Spring in 2009 was 3.4 MGD.

IDIOTS DELIGHT SPRING
Idiots Delight Spring is located on the east side of Kings Bay (Nos. 21-23, Figure 3). This spring complex is located within the Paradise Isles and Palm Island subdivision canal system. The spring consists of a group of 3 vertical shafts at least 20 feet in depth. The spring lies adjacent to the shoreline and west of the Three Sisters Springs run. The average discharge rate for Idiots Delight Spring in 2009 was 3.1 MGD.

TARPON SPRING
Tarpon Spring, is located just south of Banana Island in the southern portion of Kings Bay (No. 31, Figure 3). The largest of the springs that make up the headwaters of the Crystal River, Tarpon Spring is a popular scuba-diving location that is easily accessible by boat. This spring vent system consists of multiple holes and fractures. The fractures are in a roughly circular formation and appear to represent a large undercut shelf/cavern that collapsed sometime in the past. The depth of this vent has been previously reported as 65 feet. The 2009 average discharge rate for Tarpon Spring was 28 MGD, a value that is influenced by tidal stage.

BLACK SPRING
Black Spring (Citrus) Complex is located near the end of a canal in a residential neighborhood at the southern margin of Kings Bay (No. 38, Figure 3). The spring lies in 4 feet of water and may produce a boil at the surface of the canal. The spring is one of several vents in the area and is tidally affected. The average discharge rate for Black Spring was 3.8 MGD in 2009.

THREE SISTERS
Three Sisters is a group of three spring vents located adjacent to and north of Idiots Delight, within a small cove connected by an artificial channel to the Paradise Isles and Palm Island subdivision canal system (Nos. 18-20, Figure 3). The land area around Three Sisters was previously dominated by forested wetlands that were subsequently bulldozed and filled for residential development. A fringing growth of the original wetland forest still surrounds the Three Sisters Springs Basin. In 2013, the State of Florida in partnership with the U.S. Fish and Wildlife Service and the City of Crystal River purchased the 57-acre area surrounding and including Three Sisters Springs. This area has been partially restored and enhanced with construction of a stormwater wetland, restoration of the shoreline around the springs and the man-made Lake Linda, and construction of a manatee-viewing boardwalk around the springs. In 2009, the combined flow from the Three Sisters Springs averaged 51 MGD.
Figure 3. Forty-one named Kings Bay spring vent complexes documented in 2009.
CRYSTAL RIVER / KINGS BAY CONTRIBUTING AREA

The estimated historical contributing area for groundwater discharged by the Kings Bay/Crystal River Springs and surface runoff to the bay is shown in Figure 2. The area contributing groundwater to the Kings Bay/Crystal River Springs includes about 831 square miles in Citrus County and portions of Marion, Polk, Sumter, Lake, and Levy Counties.

The Kings Bay/Crystal River Springshed provides recharge to the Floridan Aquifer that supplies the groundwater discharging from the Kings Bay/Crystal River springs. In the recharge area, rainfall that reaches the land surface infiltrates through the soils and overlying sediments to the Upper Floridan Aquifer. This groundwater subsequently moves downgradient by gravity (from higher to lower potentiometric levels) toward the springs and coast.

All groundwater and aquifer systems are susceptible to contamination from surface sources of pollution. An aquifer vulnerability assessment provides a data-based method of estimating that susceptibility to groundwater contamination. Contamination of groundwater can result through pollution of surface waterbodies or by infiltration of pollutants through soils and sediments overlying aquifer systems. The likelihood of contamination increases in karst areas (e.g., sinkholes and other features), in areas where the aquifer is unconfined, and in areas with permeable soils, among other factors. With the exception of a relatively small area east of the Tsala-Apopka Lake system, the entire Kings Bay/Crystal River Springshed is characterized as being Vulnerable, More Vulnerable, or Most Vulnerable to contamination.

HUMAN POPULATION AND LAND USES

Significant changes in the land use of the Kings Bay/Crystal River contributing basin began with European settlement of the area in the mid-1700s. During the 1800s, major land uses included agriculture, horse and cattle ranching, and timber harvesting. By the 1900s, timber and mining activities were predominant throughout the watershed, with timber and distillation of turpentine directly affecting Kings Bay. Rapid development of the watershed during the latter part of the 1900s resulted in significant increases in urban land uses, often replacing forest and agricultural areas. These land use changes within the Crystal River/Kings Bay springshed were coincident with rapid increases in the region’s population. The estimated population of Citrus County increased from approximately 9,268 in 1960 to approximately 141,236 in 2010.

Impacts of land use activities on the Crystal River/Kings Bay system extend as far to the southeast as Polk County. The multi-county area that affects the water quality and quantity in Kings Bay/Crystal River through direct runoff and groundwater discharge has a total 2012 population of about 936,000.
GROUNDWATER PUMPING AND SPRINGFLOW REDUCTIONS

Groundwater pumping in Southwest Florida started well before the 1960s, with documented saltwater intrusion occurring in Tampa and St. Petersburg by the 1920s and 1930s. By the 1960s, water utilities in Hillsborough County alone were pumping between 55 and 60 MGD from the Floridan Aquifer. Since groundwater pumping was already resulting in some declines in regional aquifer levels, springs all along the Springs Coast had already experienced some unquantified level of anthropogenic flow reductions prior to the 1960s. It is considered probable that true baseline or pre-development spring flows at Kings Bay/Crystal River were greater than the flows reported for the 1960s and 1970s.

By 2010, there were nearly 23,000 groundwater use permits active in the Southwest Florida Water Management District (WMD) (Figure 5). It is critical to understand that much of the fresh groundwater extracted from wells would otherwise contribute to spring and diffuse groundwater discharges to coastal streams and estuaries. Since the karstic limestones of the Floridan Aquifer are interconnected throughout North Florida, spring flows at Kings Bay/Crystal River are reduced by both local and regional groundwater uses.

Figure 5. In 2010, there were a total of 22,799 consumptive use permits in the Southwest Florida WMD (indicated by yellow dots), authorizing a total daily groundwater extraction of about 2.8 billion gallons. Additional groundwater use permits in the Suwannee River Water Management District (red dots) and in the St. Johns River Water Management District (green dots) also exert a regional influence on aquifer levels and spring flows in the Springs Coast Focus Area.
Groundwater is the sole source of permitted water supply in the Springs Coast Focus Area. Total estimated groundwater extraction in the Southwest Florida WMD increased by 140% between the 1960s and 2010s, from 401 to 965 MGD. Estimated groundwater uses in the WMD in 2010 were: public supply – 32%, agriculture – 46%, commercial/industrial/mining – 7%, domestic self-supply – 7%, and recreational – 5.6%.

Continuous flow records for Crystal River are available beginning in 1965 when the river flow (about 99 percent spring flow) was reported to be between 592 and 630 MGD. In the mid-1990s, a period with below-normal rainfall and increasing groundwater withdrawals, Kings Bay/Crystal River spring flow was reported between 475 and 567 MGD. Average flow in Crystal River for the more recent period (2002 – 2015) was 292 MGD, with a declining trend between 2005 and 2010 (Figure 6). Average Crystal River flows in 2010 were about 210 MGD, and reached a record low annual average of 175 MGD in 2012. The most recent ten-year average flow was reported as 251 MGD. The overall estimated flow reduction estimated from these data based on a 1970s baseline (592 MGD) and the most recent decade of data (251 MGD) was about 340 MGD, an average reduction of 58% from the earliest recorded baseline. Declining rainfall totals account for about 14 percent of this flow reduction.

**Agricultural operations pumped 46% of groundwater extracted in 2010**
Nitrogen (N) is a plant growth nutrient that is ubiquitous in the environment. Relatively low N concentrations can cause a significant shift in the balance of spring ecological communities, resulting in the replacement of native plants by invasive exotics and nuisance algae.

Nitrate is the dominant form of N in groundwater and in spring discharges. Historically, nitrate was a minor constituent of spring water, when typical nitrate concentrations in Florida springs were lower than 0.05 milligrams per liter (mg/L). More recently, elevated concentrations of nitrate N (above 0.05 mg/L) have been found in most of Florida’s springs (Figure 7).
Springs, Figures 10 and 11). Urban and golf course fertilizers are also a substantial N source (about 222,000 pounds per year or 24% combined). The other N sources include agriculture (fertilizer and livestock, about 15%), atmospheric deposition (8.5%), and wastewater treatment facilities (2.1%). It is estimated that the annual N load to the Kings Bay/Crystal River springs is about 932,562 pounds (446 tons/year).

FDEP attributed the excessive algal growth in Kings Bay/Crystal River to nutrient enrichment. Based on laboratory and field studies, FDEP established the TMDL water quality targets. These targets account for the long residence time (low-flushing rate) conditions in Kings Bay. For the five springs listed in the TMDL, the annual average N concentration target is 0.23 mg/L. For Kings Bay as a whole, the annual average N concentration target is 0.28 mg/L. The nutrient TMDL requires reductions in N concentrations in individual springs ranging from 21 to 64 percent. This mandated reduction in N concentrations in Kings Bay/Crystal River is equivalent to a surface N load reduction of about 2.6 million pounds/year (1,305 tons/year).

Elevated spring nitrate concentrations are a result of the widespread pollution of the Floridan Aquifer due to human activities at the land surface (Figure 8). When excessive N loads are applied to vulnerable areas of the springshed, a fraction of that N leaches downward into the groundwater.

Nutrient concentrations in the major springs feeding Kings Bay continue to rise (Figure 9). Observation of these trends has triggered establishment of a Total Maximum Daily Load (TMDL) for nutrients and ongoing work to develop a Basin Management Action Plan (BMAP) for nutrient reduction. These efforts by the Florida Department of Environmental Protection (FDEP) have led to detailed evaluations of the sources and magnitudes of polluting activities in an effort to restore and protect Kings Bay/Crystal River water quality.

Nearly 42,000 septic tanks are the primary source of N loading to groundwater within the Crystal River/Kings Bay springshed (about 475,000 pounds per year or 51% of the total N load to the springs, Figures 10 and 11). Urban and golf course fertilizers are also a substantial N source (about 222,000 pounds per year or 24% combined). The other N sources include agriculture (fertilizer and livestock, about 15%), atmospheric deposition (8.5%), and wastewater treatment facilities (2.1%). It is estimated that the annual N load to the Kings Bay/Crystal River springs is about 932,562 pounds (446 tons/year).

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Figure 9. Nitrate N concentration trends in selected springs in Kings Bay. Nitrate increases in spring discharge are highest in the Hunters Cove area in northeastern Kings Bay compared to springs in the central and southern portions of the bay (Southwest Florida WMD).

Figure 10. Relative N inputs to groundwater in the Crystal River/Kings Bay BMAP area by source category (FDEP data).
SALTWATER INTRUSION

Salinity concentrations in Kings Bay/Crystal River have been increasing over the past decade (Figure 12), presumably due to increasing groundwater extractions and to ongoing sea level rise. Salinity is highest in the springs closest to the coast and lowest on the east side of Kings Bay.

The coastal-springs area is a small but important segment of a larger ground-water flow system. Continued development of groundwater resources within the coastal-springs groundwater basin alters flow and chemical characteristics of the springs and downstream estuaries. At times of high groundwater levels in the aquifer, the interface between fresh and saline water is at its greatest depth, and discharge from the springs tends to be freshest. At times of low groundwater levels, the depth to the interface is at its shallowest level. Under these conditions, saltwater in the aquifer mixes with freshwater flowing upward toward the spring openings, causing increased specific conductance in the spring discharge. High salt content of many brackish springs indicates that gulf water has intruded landward through interconnected solution conduits to the springs.

Minimum salinity in the upper reaches of Crystal River are 2-3 practical salinity units (psu), an ecologically important threshold that serves as the dividing line between a freshwater and a marine system. Fifty years ago, salinity was likely less than 1 psu. Average bay-wide salinity is now around 2.3 psu. Salinity increases are an issue in Crystal River/Kings Bay that have already led to significant changes in the ecosystem and will likely become more of a pressing concern in the future.
Figure 12. Salinity over Time at Bagley Cove. Minimum salinity over the past ten years has been steadily increasing at the gauge on Crystal River at Bagley Cove, just downstream of the mouth of Kings Bay. Maximum salinity has also increased slightly but not as much as minimum salinity indicating that the bay is getting less fresh (Southwest Florida WMD data).

WATER CLARITY

Recreational activities in Kings Bay related to diving, snorkeling and manatee viewing contribute substantially to the local economy. These activities depend a great deal upon unimpaired water clarity. Clear water has historically been a significant characteristic of the bay; however, declines in water clarity have occurred since the 1980s.

Factors known or suspected to affect water clarity in Kings Bay include concentrations of chlorophyll (a proxy measure of phytoplanktonic algae abundance), reduced flushing due to lower spring discharge, and resuspension of dead algal material and sediments from the bay bottom or from rooted aquatic plants. Resuspension of particulate materials can be exacerbated by wind, tides, boat traffic, manatee grazing and recreational activities related to diving and snorkeling. There is evidence that high amounts of aquatic vegetation in the past were associated with high water clarity in the bay.

Water clarity in Kings Bay has been reported as between 8 and 14 feet while measured clarity near Hunters Springs has generally been less than 25 feet for the past decade (Figure 13). Other springs measured throughout North Florida typically have more than 100 feet of visibility (up to 300 feet) in the vicinity of the spring boil. Existing poor water clarity conditions in Kings Bay/Crystal River system are directly responsible for reduced aesthetics as well as ecological imbalance.
BIOTA

The Kings Bay ecosystem has experienced considerable changes to fish and wildlife habitats, particularly over the past seventy years. The bay was once filled with native aquatic plants such as eelgrass which helped maintain water clarity and provided habitat for aquatic wildlife. The cover of these native plants has declined substantially due to the combined effects of invasive species (including algae), aquatic plant management measures, salinity increases, muck accumulation, and sedimentation (Figure 14). Shoreline development has also been extensive and has replaced much of the natural shoreline and adjacent wetlands surrounding the bay, which filtered the water and provided habitat.

Phytoplanktonic algae are small photosynthesizing organisms that occur in the water column in sunlit areas. Phytoplankton absorb and block sunlight from reaching aquatic life at the bottom of Kings Bay. While the production of chlorophyll is naturally occurring, elevated levels are often due to elevated nutrient concentrations and indicate water quality impairment. Some algae produce toxins, which during an algal bloom can become harmful at high concentrations. The reduction of nutrients (N and P) in the water column may have the beneficial effects of reducing chlorophyll concentrations as well as the biomass of filamentous algal mats.

Reduced spring inflows promote increased phytoplankton growth prior to being flushed out of the bay. The net result is higher water column chlorophyll levels and lower water clarity in the bay. Higher salinity in the bay also indicates reduced spring flows and longer residence times.

Native aquatic plants have been replaced by invasive algae
Figure 14. Kings Bay average biomass of submerged aquatic vegetation. Poorly considered and executed historic plant management techniques likely exacerbated the loss of eelgrass beds and inadvertently led to their replacement by a dominant cover of nuisance algae (University of Florida data).

Figure 15. Peak and average manatee winter counts in Kings Bay from 1983 through 2012 (U.S. Fish and Wildlife Service data).
WILDLIFE

Five major habitat types have been identified in the vicinity of Kings Bays/Crystal River: tidal marsh, hydric hammock, pine flatwoods, spring-run stream, and depression marsh. Twenty-one species of amphibians, 47 species of reptiles, 191 species of birds, and 22 species of mammals have been documented from the Kings Bay/Crystal River watershed.

Kings Bay provides critical warm water habitat for the Florida manatee, a large, herbivorous marine and freshwater mammal that can reach an average adult size of 10 feet long and 1,000 pounds. As migratory animals, manatees have a summer range that extends along the Atlantic and Gulf coasts, while in the winter, populations become concentrated in Florida springs to avoid hypothermia. An estimated 90 percent of the manatees utilizing Kings Bay during cold weather events are associated with Tarpon, Three Sisters, Gator Hole, and Hunters springs.

The manatee population utilizing Kings Bay has been increasing, especially since 2009 (Figure 15). As a historical comparison, during the winter of 1997 - 1998, the Kings Bay record count was 284. A recent record Kings Bay manatee count of 708 animals was set on February 20, 2015.

HUMANS

The diversity of Florida’s wildlife attracts tourists and creates jobs. Ecotourism is a major reason that non-residents visit the City of Crystal River and Kings Bay (Figure 16). Wildlife, including manatees, fish, and birds, enhance the local economy by supporting commercial and recreational fishing, diving and snorkeling activities, and manatee viewing tours. The loss of pristine habitats such as springs and estuaries can have both economic and quality-of-life implications for a community. Since recreational activities occur on and in the water, water quality and quantity are the most important aspects of ecotourism in these areas.
Figure 16. Manatee viewing and paddle sports are among the leading recreational opportunities attracting visitors to Citrus County, Florida.

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SPECIFIC GOALS FOR RESTORATION
AND PRACTICAL STEPS TO ACHIEVE THOSE GOALS

WATER QUANTITY RESTORATION

The preliminary water quantity restoration goal for the Kings Bay/Crystal River springs is to restore more than half of the estimated clear groundwater inflow that has been lost. This goal will require a reduction of regional groundwater extractions of more than 150 MGD throughout the Springs Coast Focus Area. Additional pumping reductions beyond this preliminary target may be needed to ultimately restore Kings Bay.

It is reasonable to assume that all individuals and businesses in the Kings Bay/Crystal River Springshed need to reduce their groundwater use. The Southwest Florida WMD must take the lead by increasing public awareness of the root causes of springs impairment (over pumping of groundwater) and mandating the reduction of non-essential water uses. A recommended first step will be to place a fee (Aquifer Protection Fee) on all groundwater uses. This fee would have immediate conservation and efficiency benefits by discouraging wasteful groundwater uses and would generate public revenue to help implement restoration activities.

Public and domestic self-supplies could reasonably achieve their water use reduction goal by reducing or totally eliminating landscape and lawn irrigation with groundwater. If rainfall could be stored locally in ponds, cisterns, or rain barrels, then these outside water use activities could be permitted and continued where necessary.

Agricultural production in North Florida has relatively recently developed a dependency on crop irrigation using groundwater. Crop irrigation at current rates is not compatible with healthy springs and coastal estuaries. The first step is to stop issuance of any new groundwater use permits for crop irrigation in the Southwest Florida WMD. The next step is to revise existing agricultural permits to restrict water uses to the most necessary and efficient cropping methods and to meter and charge a fee for all uses. Subsidies and tax incentives may need to be developed to lessen the impact of these types of restrictions on existing agricultural producers located in vulnerable areas. Conservation easements that convert intensive agriculture to long leaf pine forest could be funded with money from Florida’s Land and Water Amendment.

Other significant water uses in the springshed, including commercial/industrial and recreational, will also need to reduce their reliance on groundwater supplies.
WATER QUALITY RESTORATION

The preliminary target for average N concentrations in the Kings Bay/Crystal River springs is 0.23 mg/L as determined by FDEP in their nutrient TMDL. This goal will require an estimated 64% reduction in all N loads to the vulnerable portions of the springshed. To achieve the desired 64% N load reduction to the aquifer, it will be necessary to reduce the surface N loads to less than 733 tons/year, a reduction of 1,305 tons/year compared to recent loading rates.

Human wastewater N loads in the springshed can be reduced by implementing advanced N removal for all central wastewater plants and by providing centralized collection and wastewater treatment for all high-density septic tank areas. A detailed analysis evaluating and comparing N removal measures using technologies such as constructed wetlands, biological nutrient removal processes, and N-removal on-site septic systems should be prepared as part of the Kings Bay BMAP process.

All fertilizer uses will need to be significantly reduced in the vulnerable portions of the springshed to meet the 0.28 mg/L N goal. The first step to achieve this goal is placing an Aquifer Protection Fee on the sale of all N-containing fertilizers in the springshed. This fee will have the double benefit of reducing wasteful fertilizer use and raising money needed for land acquisition and wastewater treatment upgrades. The next step should include strict limits on urban and rural fertilizer use. In combination with a large reduction in landscape and agricultural irrigation, fertilizer use will decline proportionally. A phased program to reduce fertilizer use would allow greater flexibility for businesses and private homeowners to develop less-polluting cropping and landscaping strategies.

Nutrient loads originating from livestock will also need to be reduced. Ultimately, the number of large grazing animals in the springshed will need to be reduced significantly to achieve the N limit for the Kings Bay/Crystal River springs.

In summary, the anticipated Kings Bay BMAP must provide realistic but stringent N reduction measures, regardless of whether or not they adversely affect agriculture or urban land use practices. The N contamination at the Kings Bay/Crystal River springs will not be solved unless all options are on the table and implemented based on their cost effectiveness ($ per pound of N that is prevented from reaching the aquifer).

INVASIVE VEGETATION

Proliferation of benthic filamentous algae and planktonic algae throughout Kings Bay/Crystal River and springs led to adoption of the nutrient TMDL. A system-wide approach should be taken to manage exotic and invasive vegetation that includes education and coordinated efforts of interested groups to maximize effective and environmentally-sound solutions. Increased public tolerance of managed populations of invasive plants such as water hyacinth and hydrilla may be compatible with improved water clarity and springs restoration.
HOLISTIC ECOLOGICAL RESTORATION

The effects of reduced flows, increasing concentrations of nitrate N, invasions by exotic plant and animal species, and increasing recreational uses are resulting in visible long-term changes to the natural flora and fauna of the Kings Bay/Crystal River springs. Ecological restoration will require a holistic approach to dealing with all sources of impairment simultaneously, rather than a piecemeal approach of divided responsibilities by an array of state and local agencies.

Ongoing public education about the threats facing the long-term health of the Kings Bay/Crystal River and springs will be essential for achieving ultimate restoration. This Kings Bay/Crystal River Restoration Plan provides a strategy to fully accomplish restoration goals. However, getting this information out to the public and to the state officials and legislators who are most concerned with springs’ protection is an important part of the education process. This will require public presentations, newspaper and TV reporting, effective use of social media, rallies at key springs, and many partnerships. The Kings Bay Springs Alliance, Inc., Save Crystal River, Inc., and One Rake At A Time, three local non-governmental organizations, must be willing to work together and provide leadership to implement this restoration plan. Technical support will be provided by the Howard T. Odum Florida Springs Institute, university and WMD scientists, and other springs advocacy and educational organizations throughout North Florida.

REGULATORY ASSISTANCE

FDEP is currently developing a BMAP to achieve the TMDL nitrate N goals for Kings Bay/Crystal River and springs. The Southwest Florida WMD is continuously updating their Kings Bay/Crystal River Surface Water Improvement and Management Plan and continues to work on developing minimum flows and levels. Active participation by these two state agencies will be crucial to improve and implement the BMAP expeditiously to reverse the increasing nitrate levels and declining flows. This Kings Bay/Crystal River Restoration Plan can serve as the “People’s BMAP” if the FDEP and WMD plans do not provide an efficient and timely path forward to achieve success with restoration and protection of this spring system.

The Florida Department of Agriculture and Community Services (FDACS) is the state agency responsible for regulating agricultural practices in Florida. A paradigm shift is necessary at FDACS and in the development of agricultural Best Management Practices (BMPs). For example, existing BMPs are developed to maximize economic yield with less emphasis on minimizing environmental impairments. This focus on maximizing profits will not result in adequate springs’ protection. Agricultural BMPs must be re-designed to first and foremost achieve necessary environmental protections. Development of “Advanced BMPs” should include zoning restrictions on intensive agricultural activities in areas where groundwater is vulnerable to contamination. Until a better “Advanced BMP” becomes available, unfertilized, non-irrigated forestry should be mandated by FDACS for the most vulnerable karst areas of the state.
IN CLOSING

This plan documents the declining flow rates of the Kings Bay/Crystal River springs, literally the lifeblood of this natural aquarium. Average flows are currently less than one half of historic levels. To restore spring flows it will be necessary to reduce regional groundwater pumping by more than 150 MGD. This goal can be accomplished through stricter water-conservation and water-pricing measures.

Water quality in the springs feeding Kings Bay/Crystal River has been declining since the 1970s. Principal water quality issues are related to increasing concentrations of N, increasing salinity, and the resultant loss of water clarity. All of these changes are prohibited by Florida’s water laws. Whereas FDEP and the Southwest Florida WMD have been preparing plans for the past 26 years to deal with this unacceptable contamination, little has been done to alleviate these water quality problems. The result is that water quality in Kings Bay/Crystal River is continuing to decline.

Kings Bay/Crystal River’s water quality and quantity are closely related. Restoring spring flows and reducing spring nutrient concentrations will improve water clarity, reduce salinity, and make eelgrass restoration possible. Everyone desires clearer and cleaner water in Kings Bay. Everyone wishes to have access to uncontaminated groundwater for drinking and bathing. It is time to have an honest discussion about the trade-offs needed to accomplish these goals. If the current landowners and commercial interests that rely upon a healthy Kings Bay do not convince their neighbors that Kings Bay/Crystal River restoration and protection are technically and economically feasible, then no one will have the chance to enjoy the former beauty of this priceless natural resource.

Implementation of the recommendations listed above will require significant will-power and changes to “business as usual.” Eventual restoration and long-term protection of the Kings Bay/Crystal River springs will require a shift from focusing on the short-term needs of individuals and businesses to taking a longer and more holistic view for conservation and protection of clean and abundant groundwater for the public as a whole.

Groundwater is one of the most important natural resources in Florida. Currently, the groundwater that feeds the Kings Bay/Crystal River springs is neither clean nor abundant. As evidenced so clearly by the deteriorating water quality and declining spring flows at Kings Bay and Crystal River, North Florida’s groundwater resources are on a declining trajectory. Fortunately, as long as it rains, groundwater is a renewable resource. Hope for the future health of Kings Bay and Crystal River and for Florida’s springs in general is in the hands of people who have learned to appreciate and value these shared natural resources.
ACKNOWLEDGEMENTS

The Howard T. Odum Florida Springs Institute gratefully acknowledges the financial support of the Fish and Wildlife Foundation of Florida, Inc. “Protect Florida Springs” Tag Grant PFS 1415-07 for preparation of this report.

A work that attempts to encompass the entirety of a subject is always reliant on the work of others. This Restoration Action Plan incorporates the work of professionals from virtually every environmental research institution and agency in Florida, including the Southwest Florida Water Management District, the U.S. Geological Survey, the U.S. Fish and Wildlife Service, the Florida Department of Environmental Protection, the Florida Fish and Wildlife Conservation Commission, the University of Florida, and engineering and environmental consultants.

A debt of gratitude is owed to the non-profit King’s Bay Springs Alliance, a citizen’s advocacy group, for their long-term support of the Kings Bay and Crystal River springs ecosystems. Sincere thanks are given to Florida nature photographer John Moran, Springs Eternal Project, who captured the outstanding image of a Three Sisters Springs manatee reproduced on this report’s cover.

About FSI

The Howard T. Odum Florida Springs Institute is a 501(c)(3) non-profit corporation working toward the vision of having a permanent research center focused on springs and aquatic ecology and education at a major Florida spring. We are devoted to developing restoration and management goals for as many springs as possible and advocating for their protection and restoration.