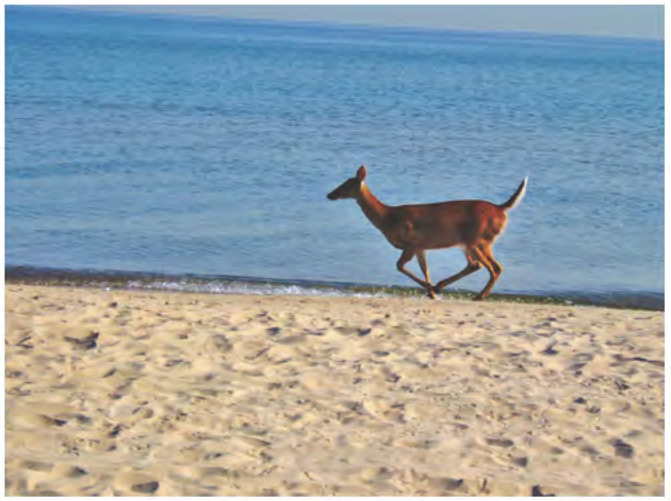

CHAPTER 4
Environmental Consequences

INTRODUCTION

This "Environmental Consequences" chapter analyzes both beneficial and adverse impacts that would result from implementing any of the alternatives considered in this *Shoreline Restoration and Management Plan / Draft Environmental Impact Statement* (EIS). The "Environmental Consequences" chapter also includes the methodology and definitions of impact thresholds (e.g., negligible, minor, moderate, and major), methods used to analyze impacts, the analysis used for determining cumulative effects, and a cumulative impacts scenario. A summary of the environmental consequences for each alternative is provided in tables 2-3 and 2-4, which can be found in "The Alternatives" chapter. The resource topics presented in the "Environmental Consequences" chapter, and the organization of the topics, correspond to the resource discussions contained in the "Affected Environment" chapter.

GENERAL METHODOLOGY FOR ESTABLISHING IMPACT THRESHOLDS AND MEASURING EFFECTS BY RESOURCE

The following elements were used in the general approach for establishing impact thresholds and measuring the effects of the alternatives on each resource category:

- general analysis methods as described in the guiding regulations
- basic assumptions used to formulate the specific approaches used in this analysis
- thresholds used to define the intensity of impact resulting from each alternative
- methods used to evaluate the cumulative effects of each alternative in combination with unrelated factors or actions affecting park resources

These elements are described in the following sections.

General Analysis Methods

The analysis of impacts follows CEQ guidelines and Director's Order 12: *Conservation Planning, Environmental Impact Analysis, and Decision-making* procedures (NPS 2001) and is based on the underlying goals of restoring natural shoreline processes, preserving the shoreline ecosystem, and providing opportunities for quality visitor experiences consistent with the purpose and significance of the park. This analysis incorporates the best available scientific literature applicable to the region and setting and the actions being considered in the alternatives.

The National Park Service has created an interdisciplinary team to provide important input to the impact analysis. For each resource topic addressed in the "Environmental Consequences" chapter, the applicable analysis methods are discussed.

Assumptions

Several guiding assumptions were made to provide context for this analysis. These assumptions are described below.

Analysis Period. For goals, objectives, and specific implementation actions needed to restore and manage the shoreline at Indiana Dunes National Lakeshore, a 20-year lifespan of each alternative was assumed. Thus, the analysis period used for assessing impacts in this plan / draft EIS is 20 years.

The National Park Service assumes that beach nourishment via any of the alternatives would require time to monitor and oversee the actions associated with each of the

alternatives for the duration of the plan (i.e., 20 years).

Duration and Type of Impacts

The following assumptions were used for all impact topics (the terms "impact" and "effect" are used interchangeably throughout this document):

- Short-term impacts are impacts that would be temporary, lasting for one year or less following an action.
- Long-term impacts are impacts that would last longer than one year and that would be permanent.
- Direct impacts are impacts that would be directly caused by a shoreline management action which would occur when and where the action was implemented.
- Indirect impacts are impacts that would occur from shoreline management actions that would occur later in time or farther in distance than when and where the action was implemented.

Geographic Area Evaluated for Impacts. The geographic project area for this plan includes beach reaches 1 through 4 in Indiana Dunes National Lakeshore, as described in "The Alternatives" chapter.

For the alternatives assessed, it is assumed that providing several thousands of cubic yards of nourishment material to reach 1 would affect not only reach 1, but reach 2 and a portion of reach 3, as well. Likewise, providing several thousands of cubic yards of nourishment material to reach 3 would indirectly affect downdrift shorelines within reach 4. The additional nourishment material in reach 3 would be transported downdrift by natural processes (i.e., wave action and storm events).

Future Trends. Visitor use and demand are anticipated to follow trends similar to recent years. The number of yearly visitors to Indiana Dunes National Lakeshore is about two million. In the absence of notable anticipated changes in visitation and park staffing, the impact analysis assumes these levels would remain similar to present levels.

IMPACT THRESHOLDS

Determining impact thresholds is a key component in applying NPS *Management Policies 2006* and Director's Order 12. These thresholds provide the reader with an idea of the intensity of a given impact within a specific topic. The impact threshold is determined primarily by comparing the effect to a relevant standard based on regulations, scientific literature and research, or best professional judgment. Intensity definitions are provided separately for each impact topic analyzed in this document because definitions of intensity vary by impact topic. Intensity definitions are provided throughout the analysis for negligible, minor, moderate, and major impacts.

CUMULATIVE EFFECTS ANALYSIS METHOD

The CEQ regulations for implementing the National Environmental Policy Act of 1969, as amended (NEPA) require an assessment of cumulative effects in the decision-making process for federal projects. Cumulative impacts are defined as "the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 Code of Federal Regulations [CFR 1508.7). These actions were identified, and cumulative impacts were determined, by combining the impacts of alternatives with those of the other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other ongoing or reasonably foreseeable future projects at Indianan Dunes National Lakeshore and, if applicable, the surrounding region. The geographic scope for this analysis

includes elements mostly within the shoreline of southern Lake Michigan, while the temporal scope includes projects within a range of approximately 20 years. Given this, the following projects were identified for the purpose of conducting the cumulative effects analysis.

CUMULATIVE IMPACT SCENARIO

Past Actions Within and Around Indiana Dunes National Lakeshore

- Three man-made structures that constitute barriers to littoral drift and affect the park were constructed in and around the project area. These structures are federal and industrial harbors that impact the natural sediment transport by disrupting water flow and producing accretion to the east (updrift) and erosion to the west (downdrift). These include the east adjacent Michigan City Harbor (initial construction in 1834, harbor completed in the early 1900s), the Port of Indiana industrial complex (constructed in the late 1960s), and the west adjacent Gary-U.S. Steel breakwater (constructed in the early 1900s).
- A permanent electric barrier was constructed by the U.S. Army Corps of Engineers (COE) in the Chicago Sanitary and Ship Canal to deter movement by invasive nonnative fish species across this artificial connection between the Mississippi River and Great Lakes drainages.
- The park designated the appropriate route to and from Mount Baldy from the parking lot in an effort to reduce social trails in reach 1 of the beach.
- The initial Marquette Plan: The Lakeshore Reinvestment Strategy (IDNR *et al*. 2005) was completed in 2005 and addressed public access and redevelopment of Indiana Dunes National Lakeshore from the Illinois state line to the Port of Indiana, with funding by the cities of Whiting, East Chicago, Hammond, Gary, and Portage. Portage Lakefront and Riverwalk are results of this plan.
- Industrial complexes in the area, like the Northern Indiana Public Service Company (NIPSCO), were constructed and became operational.
- Transportation corridors were constructed within and around the park.

Present Actions Within and Around Indiana Dunes National Lakeshore

- Clean sediment nourishment is accepted from upland sources on an intermittent basis in reach 1.
- The park is restoring the foredune and dune complex by stabilizing select areas of eroded dunes with native vegetation, fencing off highly eroded and environmentally sensitive areas, and providing expanded visitor outreach and education opportunities about these actions.
- The park installs fencing to protect the leeward slope of Mount Baldy to limit anthropogenic influences in reach 1.
- The park manages invasive vegetation, currently targeting sand ryegrass (*Leymus arenarius*) and spotted knapweed (*Centaurea maculosa*) in the foredune complex; purple loosestrife (*Lythrum salicaria*), common reed (*Phragmites australis*), and hybrid cattail (*Typha* x *glauca*) in the panne; and some woody invasive vegetation, such as Siberian elm (*Ulmus pumila*), black locust (*Robinia pseudoacacia*), and tree-of-heaven (*Ailanthus altissima*), throughout these complexes in reaches 1 and 2.
- Clean sediment nourishment is accepted from lake dredging projects on an intermittent basis in reach 3.
- At blowout locations, including Portage Lakefront and Riverwalk, some invasive plant management is performed to help protect Pitcher's

thistle (*Cirsium pitcheri*) populations in reaches 3 and 4; the U.S. Geological Survey monitors these populations.

- Nonnative invasive plant species are being managed in the panne in reaches 3 and 4. These efforts target spotted knapweed, yellow sweet clover (*Melilotus officinalis*), and prairie sunflower (*Helianthus petiolaris*) at Portage Lakefront and Riverwalk; purple loosestrife and common reed in the panne; and sand ryegrass in the foredune complex. In addition, some management of oriental bittersweet (*Celastrus orbiculatus*) (that is encroaching on the dune complex) is performed.
- The park is currently preserving the pannes at West Beach and Miller by managing invasive nonnative plant species, targeting purple loosestrife, common reed, and hybrid cattail in reach 4.
- Ongoing planned facility upgrades are performed in the park.
- To limit anthropogenic influences in the park, the staff provides education and outreach to visitors.
- Current resource protection and restoration projects in the park include an early detection and rapid response program and an Invasive Plant Management Plan.
- The park maps and monitors treated nonnative invasive plant species in Indiana Dunes National Lakeshore.
- The park provides education and outreach about the impacts of invasive nonnative plant species.
- The Northern Indiana Commuter Transportation District (the South Shore Railroad) traverses the park.
- The Super Boat Grand Prix, a high-speed offshore boat race sponsored by Michigan City, is held annually near the park.
- The Calumet Harbor and River project involves dredging various segments of the Calumet River to maintain channel depth (allowing continued commodity exchange and transport). The Calumet Harbor, which is the second largest port on the Great Lakes, is the primary link between the Inland-Waterway system, foreign ports, and the Great Lakes (and is one of only two possible routes between these) (COE 2011c).
- Ships' ballast water has accounted for 55% to 70% of reported aquatic invasive species introductions in to the Great Lakes since 1959, when the St. Lawrence Seaway opened and provided a route in to the Great Lakes for trade (National Academy of Sciences 2008).

Reasonably Foreseeable Future Actions Within and Around Indiana Dunes National Lakeshore

- The park proposes to develop a picnic area near the Porter access point.
- NIPSCO is going to realign the outflow at the Bailly Generating Station.
- The town of Michigan City proposes to build a parking lot east of Mount Baldy for access to Crescent Dune.
- Phase II of the Marquette Plan (IDNR *et al.* 2005), which focuses on Indiana Dunes National Lakeshore from the Port of Indiana to the Michigan-Indiana state line, is being funded through a grant from the Indiana Department of Natural Resources (IDNR) Lake Michigan Coastal Program with matching funds from the Gaylord and Dorothy Donnelley Foundation, the cities of La Porte and Michigan City, and La Porte County. This plan focuses on identifying the needs of the smaller communities and creating a vision that would identify and protect greenways, identify possible trails in the region, and address the needs of smaller communities.

- The park is considering realigning some trails, as well as developing a mitigation plan for new/proposed access points and trails to Crescent Dune to limit anthropogenic influences.
- The park plans to enforce visitor use of approved trails in the park in all reaches to limit anthropogenic influences.
- To help limit social trails in reach 1, the park plans to designate an appropriate route to the beach from the Kemil Road parking lot, and to the foredune complex, including blowouts, from the Kemil Road access point.
- The park proposes to restore the foredune and dune complex by stabilizing eroded dunes with native vegetation, and fencing off highly eroded and environmentally sensitive areas on the foredune to allow for ecological recovery of natural communities.
- The park proposes to expand current public education and outreach efforts.
- Outside of the proposed project area, no additional modifications to the shoreline are likely, as the harbors and breakwaters associated with the adjacent federal and industrial harbors have already been constructed. It cannot be predicted whether owners of adjacent properties would continue to armor or otherwise modify their respective beachfronts. In the event that additional shoreline structures are constructed, the littoral drift along Lake Michigan's shoreline would continue to be disrupted and result in additional challenges to the natural and human environment at Indiana Dunes National Lakeshore.
- Future introductions of aquatic invasive species from ships' ballast water may be effectively managed through ballast water management techniques, such as ballast water exchange, saltwater flushing, or shipboard treatment, and through restricting access to the Great Lakes to vessels that have taken protective measures like these to ensure they do not harbor aquatic invasive species.

COASTAL PROCESSES

METHODOLOGY

Resource specialists conducted site visits to the park to observe existing conditions and assess the potential effectiveness of the alternatives in addressing the issues involved in the restoration of natural coastal processes. Various technical documents were reviewed to understand the history of beach nourishment activities and the factors involved in coastal processes, sediment transport, and dune formation. Alternatives were evaluated based on the potential to respond to the desired future conditions, including the effectiveness of the alternative in balancing the quantities of sediment throughout the project area, fulfilling the estimated sediment budget deficit, preventing continued erosion in critical areas of the shoreline, and providing for the natural processes of dune formation.

Impact Intensity Level Definitions

Intensity level thresholds for coastal processes are defined as follows:

Negligible: The impact is barely detectable, and would result in no noticeable or perceptible changes to the sediment transport and/or dune formation processes.

Minor: The impact is slight but detectable, and would result in small but noticeable changes to the sediment transport and/or dune formation processes.

Moderate: The impact is readily apparent, and would result in easily detectable changes to the sediment transport and/or dune formation processes.

Major: The impact is severely adverse, or exceptionally beneficial, and would result in appreciable changes to the sediment transport and/or dune formation processes.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

Alternative A (No-action Alternative)

Sediment Transport Processes. The dunes, the swash zone, and the nearshore area are dynamic high-energy areas, subject to the forces of wind and waves. Sediment is moved offshore in the winter and returns onshore in the spring and summer. Sediment placed on the shoreline during beach nourishment activities is re-distributed between the zones in a more stable profile. Despite current nourishment efforts to stabilize the shore, erosion of the shoreline would continue as the quantity of material currently being placed is less than the estimated sediment budget deficit. The accretion area at Michigan City would continue to grow because sediment is being transported to the shoreline from upland sources, as sediment supply meant to drift naturally along the shoreline is blocked by the existing navigational structure (i.e., Michigan City Harbor).

Although the existing program of beach nourishment has had a positive effect in reducing the annual sediment budget deficit, the amount of sediment being placed along the shoreline is substantially less than the estimated loss, leaving the sediment budget deficit. Therefore, selection of the no-action alternative would result in a moderate, long-term, adverse impact, due to the continued sediment budget deficit and shoreline erosion.

Dune Formation Processes. The current nourishment program includes placing material primarily on the beach at Crescent Dune, and using heavy equipment to grade the material into a more natural topography. Shoreline sediment is transported by natural processes (i.e., wave action, wind) to the foredune area where it provides material for dune formation. The amount of material

placed during current beach nourishment activities is less than the annual sediment loss, resulting in continued erosion. The existing nourishment program has helped reduce impacts on dune formation; however, due to the sediment budget deficit, dune erosion would continue under the no-action alternative. Therefore, the no-action alternative would result in moderate, long-term, adverse impacts on dune formation processes.

Cumulative Impacts. The "Cumulative Impact Scenario" section of the "Environmental Consequences" chapter describes the past, present, and reasonably foreseeable future actions in or surrounding the project area. Many of these actions have affected coastal processes, including the construction of man-made structures, which have impacted the natural littoral drift along the lakeshore. The main structure affecting reaches 1 and 2 is the Michigan City Harbor. Construction of the harbor resulted in areas of accretion (east of the harbor) and areas of erosion (west of the harbor). Additionally, the Calumet Harbor and River project and its associated dredging activities affect littoral drift in the Great Lakes resulting in sediment accretion and sediment budget deficits along shorelines in the project area. Present beach nourishment activities have provided some sediment in the areas of erosion, but volumes are inadequate to account for the annual sediment budget deficit, and do not address issues of sediment accretion. No future modifications to the shoreline have been identified within reaches 1 and 2, as surrounding and adjacent federal and industrial harbors and other man-made shoreline structures have already been constructed. Cumulative impacts on coastal processes under alternative A would be moderate, long-term and adverse.

Conclusion. Despite the continuation of the current nourishment program by the COE, under the no-action alternative, sediment budget deficit and erosion would continue to affect Indiana Dunes National Lakeshore's sandscapes and shorelines, resulting in an overall moderate, long-term, adverse impact. As erosion continued, the integrity of cultural and natural resources along the shoreline, as well as nearby infrastructure would be threatened. Additionally, existing navigational and industrial structures along the lakeshore would continue to disrupt sediment transport. Cumulative impacts on coastal processes under alternative A would be moderate, long-term and adverse. Actions under alternative A would provide no incremental increase to the overall cumulative impacts.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)

Sediment Transport Processes. Under alternative B-1, sediment would be mined and placed on the beach each year from a permitted upland source. Placing additional sediment on the beach in reach 1 would initially increase beach size within the placement area in front of Crescent Dune and Mount Baldy. The additional nourishment material would be sufficient to maintain the current shoreline position for approximately one year, as natural wave action would continue to erode the sediment after placement. The shorelines downdrift of Crescent Dune and Mount Baldy would receive a large infusion of sediment following the material placement, affecting not only reach 1, but reach 2 and a portion of reach 3, as well. The accretion area at Michigan City would continue to grow because sediment would be transported to the beach from an upland source and sand supply meant to drift naturally along the shoreline would be blocked by the existing navigational structure.

Implementing alternative B-1 would result in moderate, long-term, beneficial impacts as the estimated sediment budget deficit quantity would be provided.

Dune Formation Processes. Under alternative B-1, sediment would be mined and placed on the beach each year from a permitted upland source. The placed

sediment would erode over the course of approximately one year. Placement of the sediment would provide additional material available on land for aeolian transport, thus encouraging foredune development. Beach placement also would provide some buffering against storm events. The additional sediment on the beach would protect the current shoreline profile from increased erosion resulting from intense wave action, particularly during storm events.

The actions associated with alternative B-1 would result in moderate, long-term, beneficial impacts as the sediment placed on the beach, in conjunction with wind action, would allow for additional sediment supply to create foredunes.

Cumulative Impacts. Cumulative impacts would generally be similar to those described for alternative A, with the exception that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. Cumulative impacts on coastal processes would be negligible to minor, long-term and adverse. The existing man-made structures would persist and continue to create areas of accretion and sediment budget deficit, which would require continued beach nourishment activities to mitigate.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 1 would account for the estimated sediment budget deficit, and thereby maintain the current shoreline profile. Actions under alternative B-1 would also provide additional sediment to encourage foredune development along the shoreline, resulting in moderate, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible to minor, long-term and adverse.

Actions under alternative B-1 would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)

Sediment Transport Processes. Under alternative B-5, a five-year quantity of sediment would be mined and placed on the beach every five years, initially increasing beach size along the length of reach 1. The additional nourishment material would be sufficient to maintain the current shoreline position for approximately five years, as natural wave action would continue to erode the sediment after placement. The shorelines downdrift of reach 1 would receive a large infusion of sediment following the material placement, affecting not only reach 1, but reach 2 and a portion of reach 3, as well. The accretion area at Michigan City, and the beach at Washington Park, would continue to grow because sediment would be transported from upland sources and sediment supply meant to drift naturally along the shoreline would be blocked by the existing navigational structure.

The actions associated with alternative B-5 would result in moderate, long-term, beneficial impacts, as the estimated sediment budget deficit quantity would be provided.

Dune Formation Processes. A five-year quantity of mined sediment on the beach in reach 1 would erode over the course of approximately five years. Placement of the sediment would provide additional material available on land for aeolian transport, thus encouraging foredune development. Placing a five-year quantity of sediment on the beach would result in additional protection against storm events. The additional sediment would help protect the current shoreline profile against increased erosion from intense wave action, particularly during storm events. The actions associated with alternative B-5 would result in moderate to major, long-term, beneficial impacts as the additional material

on the beach, in conjunction with wind action, would encourage foredune development. The additional material would also provide more buffering against intense storm events than the smaller amount of sediment provided for under an annual program of beach nourishment.

Cumulative Impacts. Cumulative impacts would generally be as described for alternative A, with the exception that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. Cumulative impacts on coastal processes would be negligible, long-term and adverse. The impacts of the existing man-made structures would persist, continuing to create areas of accretion and erosion, which would require the continued beach nourishment activities to mitigate.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 1 every five years would account for the estimated sediment budget deficit, and thereby maintain the current shoreline profile. The actions associated with alternative B-5 would also provide a large quantity of sediment on the beach to facilitate foredune development along the shoreline, resulting in major, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible, long-term and adverse.

Actions under alternative B-5 would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Sediment Transport Processes. Under alternative C-1, sediment would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, and be placed along the beach in reach 1. As under alternative B-1, placing additional sediment on the beach in reach 1 would result in an initial increase in beach size within the placement area at Crescent Dune. The additional nourishment material would be sufficient to maintain the current shoreline position for approximately one year, as natural wave action would continue to erode the sediment after placement. The shorelines downdrift of Crescent Dune and Mount Baldy would receive a large infusion of sediment, originating from Lake Michigan, following the material placement, affecting not only reach 1, but reach 2 and a portion of reach 3, as well.

Transporting sediment from an updrift to a downdrift location would mimic natural processes as the material used would remain within the Lake Michigan system. Implementing alternative C-1 therefore would result in moderate to major, long-term, beneficial impacts as the estimated sediment budget deficit would be provided from an updrift source, more closely mimicking natural processes.

Dune Formation Processes. Under alternative C-1, additional sediment would be dredged from an updrift location and placed at Crescent Dune. This sediment would erode over the course of approximately one year. Placement of the sediment would provide additional material available on land for aeolian transport, thus encouraging foredune development. Beach placement would provide some buffering against storm events. The additional sediment on the beach would protect the current shoreline profile from increased erosion resulting from intense wave action, particularly during storm events.

Implementing alternative C-1 would result in moderate, long-term, beneficial impacts as the sediment placed on the beach, in conjunction with wind action, would allow for additional sediment supply to create foredunes.

Cumulative Impacts. Cumulative impacts under alternative C-1 would generally be as described for alternative A, with the exception

that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. Additionally, sediment would be taken from an updrift location that would more closely mimic the natural coastal processes as the material used would remain within the Lake Michigan system. Cumulative impacts on coastal processes would be negligible to minor, long-term and adverse.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 1 would account for the calculated sediment budget deficit, and thereby maintain the current shoreline profile. Additionally, dredging sediment from an updrift location would more closely mimic natural processes, as compared to using material from upland sources. Implementing alternative C-1 would also provide additional sediment to encourage foredune development along the shoreline, resulting in moderate to major, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible to minor, long-term and adverse.

Actions under alternative C-1 would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)

Sediment Transport Processes. As described under alternative C-1, sediment would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, and would be placed along the beach in reach 1; however, under alternative C-5, a five-year quantity would be used to nourish the beach. Placing a five-year quantity of sediment in reach 1 would initially increase beach size along the length of reach 1. The additional nourishment material would be sufficient to maintain the current shoreline position for approximately five years, as natural wave action would continue to erode the sediment after placement. The shorelines downdrift of reach 1 would receive a large infusion of sediment, originating from Lake Michigan, following the material placement, affecting not only reach 1, but reach 2 and a portion of reach 3, as well.

Transporting sediment from an updrift to a downdrift location would mimic natural processes, as material used would remain within the Lake Michigan system. Implementing alternative C-5 therefore, would result in moderate to major, long-term, beneficial impacts as the estimated sediment budget deficit would be provided from an updrift source, more closely mimicking natural processes.

Dune Formation Processes. Under alternative C-5 a five-year quantity of sediment would be dredged from an updrift location and placed at Crescent Dune, providing additional sediment along the majority of reach 1. This sediment would erode over the course of approximately five years. Placement of the sediment would provide additional material available on land for aeolian transport, thus encouraging foredune development. Placing a five-year quantity of sediment on the beach would provide additional protection against storm events. The additional sediment on the beach would protect the current shoreline profile from increased erosion resulting from intense wave action, particularly during storm events. Implementing alternative C-5 would result in moderate to major, long-term, beneficial impacts as the additional quantity of material on the beach, in conjunction with wind action, would encourage foredune development. The additional quantity of material would also provide buffering against intense storm events.

Cumulative Impacts. Cumulative impacts under alternative C-5 would generally be as described for alternative A, with the exception

that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. Additionally, there would be a reduction in areas of accretion, which would be used as sources of sediment for beach nourishment operations. Cumulative impacts on coastal processes would be negligible, long-term and adverse.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 1 every five years would account for the estimated sediment budget deficit, and thereby maintain the current shoreline profile. Implementing alternative C-5 would also provide a large quantity of sediment on the beach from an updrift source to facilitate foredune development along the shoreline, resulting in moderate to major, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible, long-term and adverse.

Actions under alternative C-5 would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

Alternative D (Beach Nourishment via Permanent Bypass System)

Sediment Transport Processes. Under alternative D, sediment would be placed along the beach in reach 1 from updrift of the Michigan City Harbor, and transported to the shoreline via a permanent bypass system. As with the previously described alternatives, placing additional sediment on the beach in reach 1 would result in an initial increase in beach size within the placement area at Crescent Dune. The additional nourishment material would be sufficient to maintain the current shoreline position for approximately one year, as natural wave action would continue to erode the sediment after placement. The shorelines downdrift of Crescent Dune and Mount Baldy would receive an infusion of sediment following the material placement, affecting not only reach 1, but reach 2 and a portion of reach 3, as well.

Transporting sediment from an updrift to a downdrift location in this manner would mimic the natural processes, as material used in beach nourishment would remain within the Lake Michigan system. Implementing alternative D therefore, would result in moderate to major, long-term, beneficial impacts as the estimated sediment budget deficit would be provided from a source updrift, more closely mimicking natural processes.

Dune Formation Processes. Under alternative D, sediment would be transported to the shoreline in reach 1 via a permanent bypass system from updrift of the Michigan City Harbor. Under alternative D, placed material would erode over the course of approximately one year. Placement of the sediment would provide additional material available on land for aeolian transport, thus encouraging foredune development. Beach placement also would provide some buffering against storm events. The additional sediment on the beach would protect the current shoreline profile from increased erosion resulting from intense wave action, particularly during storm events.

Implementing alternative D would be moderate, long-term, beneficial impacts as the sediment placed on the beach, in conjunction with wind action, would provide additional sediment supply to create foredunes.

Cumulative Impacts. Cumulative impacts under alternative D would generally be as described for alternative A, with the exception that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. Additionally, there would be a reduction in areas of accretion which would be used as sources of sediment for beach nourishment operations. Cumulative impacts would be negligible to minor, long-term and adverse.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 1 would account for the estimated sediment budget deficit, and thereby maintain the current shoreline profile. Additionally, dredging sediment from an updrift location would more closely mimic natural processes, as compared to using material from upland sources. Implementing alternative D would also provide additional sediment to encourage foredune development along the shoreline, resulting in moderate to major, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible to minor, long-term and adverse.

Actions under alternative D would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative

Sediment Transport Processes. Under alternative E, a submerged cobble berm along the shoreline of reach 1 would be constructed. The submerged cobble berm would be comprised of appropriate-sized aggregate material from local glacial deposits which would be re-distributed across the lake bottom by natural wave action. The distribution would move the smaller aggregate closer to the shoreline, while the larger material would generally stay within a few feet of the submerged cobble berm. Distribution would be variable, depending on the intensity of storm events. Prior to breakdown of the submerged cobble berm, wave energy within the nearshore would be dissipated, thus increasing the likelihood of sediment retention in the nearshore. After the submerged cobble berm has been spread along the lake substrate, lakebed down-cutting would decrease as the aggregate material would create a protective layer.

The submerged cobble berm would be used in conjunction with a beach nourishment program to restore reach 1. The potential exists for reduced nourishment quantities, as the submerged cobble berm would increase sediment retention. The placement of nourishment material would be conducted to mitigate erosion within reach 1, and to maintain the current shoreline profile.

A moderate, long-term, beneficial impact on sediment transport processes would result from implementing alternative E. Annual nourishment from a dredged source located east, updrift of the Michigan City Harbor structure, would more closely mimic natural processes. Material used for the submerged cobble berm would provide additional protection of the clay sill on the lake bottom and would be similar to material historically found in reach 1. The submerged cobble berm, and the eventual distribution of its aggregate material, would help protect the shoreline from erosion due to storm events, and maintain a more stable shoreline profile.

Dune Formation Processes. Under alternative E, the submerged cobble berm would be used in conjunction with a beach nourishment program to restore reach 1 of Indiana Dunes National Lakeshore. Placement of the sediment would provide additional material available on land for aeolian transport, thus encouraging foredune development. Beach placement also would provide some buffering against storm events. The submerged cobble berm would provide additional retention of sediment in the area of placement.

Implementing alternative E would result in moderate, long-term, beneficial impacts as the submerged cobble berm would provide longer retention of the sediment. The material placed on the beach in conjunction with the submerged cobble berm, would allow for additional sediment supply to create foredunes. Beach placement of nourishment

materials also would provide some buffering against storm events.

Cumulative Impacts. Cumulative effects under alternative E would generally be similar to those described under alternative A. The combination of the effects of the submerged cobble berm along with beach nourishment activities would create and maintain a more natural and stable shoreline. Cumulative effects under alternative E would be negligible, long-term and adverse.

Conclusion. Constructing a submerged cobble berm in addition to placing nourishment material from an updrift source would account for the estimated sediment budget deficit, and thereby maintain the current shoreline profile. Placing cobble aggregate material from local glacial deposits in reach 1 would more closely replicate material historically found in this area of the shoreline. Additionally, dredging sediment from an updrift location would more closely mimic natural processes, as compared to using material from upland sources. Implementing alternative E would increase sediment retention in the area of placement, provide additional sediment to encourage foredune development along the shoreline, and would result in moderate, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible, long-term and adverse.

Actions under alternative E would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Alternative A (No-action Alternative)

Sediment Transport Processes. Under alternative A, sediment would continue to be dredged annually around the NIPSCO/Bailly intake. The dredged material would be placed in the nearshore at Portage Lakefront and Riverwalk, while sediment from Burns Waterway Small Boat Harbor would have an offshore, open-water placement. Despite intermittent nearshore placement activities associated with dredging, erosion of the shoreline would continue as the quantity of material being placed would not address the sediment budget deficit in the area. Additionally, nearshore placement would typically be less effective than beach nourishment as less sediment would be transported via wave action to the shoreline.

Although implementing the no-action alternative would propose continuing current dredging and placement of sediment in the nearshore, an annual sediment budget deficit in the erosion areas of the lakeshore would still result. The sediment being placed in the nearshore at Portage Lakefront and Riverwalk would continue to help reduce the sediment budget deficit; however, the area would still experience a net loss of sediment, impacting the natural sediment transport processes. Accordingly, impacts under the no-action alternative would be minor to moderate, long-term and adverse. As dredging of the intake area would be intermittent, the accretion areas would continue to grow, potentially achieving a stable profile and allowing sediment to bypass harbor structures. Sediment would accumulate in the navigational channel, and the sediment would adversely affect the intake as well as a warm-water industrial discharge point.

Dune Formation Processes. Current management practices by the COE include dredging material from around the NIPSCO/Bailly intake, and placing that sediment in the nearshore at Portage Lakefront and Riverwalk. Placement of sediment in this area is less effective relative to foredune creation than if it were placed on the beach, as much of the material would be transported downdrift or further lakeward to open waters rather than towards the shoreline. Subsequently, less is available to be

transported via wind action onto the beach to form embryonic dunes. If the no-action alternative were implemented, beach erosion would continue, thus threatening park infrastructure along the shoreline. Taking no new actions in the park would result in minor to moderate, long-term, adverse impacts.

Cumulative Impacts. The primary past and present actions that have affected coastal processes are the construction of man-made structures, which have impacted the natural littoral drift along the lakeshore. The main structures in reaches 3 and 4 are associated with the Port of Indiana and Gary-U.S. Steel breakwater. The presence of these structures has resulted in areas of accretion (east of the structures), and areas of sediment budget deficit (west of the structures). Additionally, there are sections of shoreline that are armored with steel-sheet piling and stone revetments, which have also altered natural shoreline conditions. The Calumet Harbor and River project and its associated dredging activities affect littoral drift in the Great Lakes resulting in sediment accretion and sediment budget deficits along the shoreline. Present dredging activities in the accretion areas, and beach nourishment activities in the areas with severe erosion, have helped lessen the existing impacts, but are not adequate to account for the annual sediment budget deficit, and do not fully address issues of sediment accretion. No future modifications to the shoreline have been identified within reaches 3 and 4, as most federal and industrial harbors and other man-made shoreline structures have already been constructed. Cumulative impacts on coastal processes under alternative A would be moderate, long-term and adverse.

Conclusion. Despite the continuation of the current dredging program and nearshore placement of sediment by the COE, under the no-action alternative, erosion would continue to affect Indiana Dunes National Lakeshore's sandscapes and shorelines. This would result in an overall minor to moderate, long-term, adverse impact. As erosion continues, the integrity of cultural and natural resources along the shoreline, as well as nearby infrastructure would be threatened. Additionally, existing navigational and industrial structures along the lakeshore would continue to interrupt sediment transportation. Cumulative impacts on coastal processes under alternative A would be moderate, long-term and adverse. Actions under alternative A would provide no incremental increase to the overall cumulative impacts.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Sediment Transport Processes. Under alternative C-1, sediment would be dredged from an updrift location in Lake Michigan and placed annually on the beach at Portage Lakefront and Riverwalk. This would initially increase beach size within the placement area. The additional nourishment material would be sufficient to maintain the current shoreline position for approximately one year, as natural wave action would continue to erode the sediment after placement. The shorelines downdrift of the placement area at Portage Lakefront and Riverwalk would receive a large infusion of sediment following the material placement, affecting reach 4.

Transporting sediment from an updrift to a downdrift location mimics the natural processes, as material used would remain within the Lake Michigan system. Implementing alternative C-1 therefore, would result in moderate, long-term, beneficial impacts as the sediment would be provided from an updrift source, more closely mimicking natural processes.

Dune Formation Processes. Under alternative C-1, sediment would be dredged from an updrift location in Lake Michigan and placed annually on the beach at Portage Lakefront and Riverwalk. Placement of the sediment would provide additional material available on land for aeolian transport, thus encouraging foredune development. Beach

placement also would provide some buffering against storm events. The additional sediment on the beach would protect the current shoreline profile from increased erosion resulting from intense wave action, particularly during storm events.

Implementing alternative C-1 would result in moderate, long-term, beneficial impacts as the sediment placed on the beach, in conjunction with wind action, would allow for additional sediment supply to create foredunes.

Cumulative Impacts. Cumulative impacts under alternative C-1 would generally be as described for alternative A, with the exception that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. Cumulative effects would be negligible to minor, long-term and adverse.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 3 would mitigate the sediment budget deficit, and thereby protect the current shoreline profile. Additionally, dredging sediment from an updrift location would more closely mimic natural processes as compared to using material from upland sources. Actions associated with alternative C-1 would also provide additional sediment to encourage foredune development along the shoreline, resulting in moderate, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible to minor, long-term and adverse.

Actions under alternative C-1 would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative

Sediment Transport Processes. Under alternative C-5, the five-year quantity of sediment to be placed on the beach in reach 3 would occur via dredging from an updrift location in Lake Michigan, such as near the NIPSCO/Bailly intake. The approximate 370,000 cubic yards (yd^3) of sediment would initially increase beach size along the length of reach 3, and would be sufficient to maintain the current shoreline position for approximately five years, as natural wave action would continue to erode the sediment after placement. The shoreline downdrift of reach 3 would receive a large infusion of sediment following the material placement, affecting reach 4. The large amount of sediment placed on the beach under alternative C-5 would increase the potential for there to be increased sedimentation at the Burns Waterway Small Boat Harbor, due to sediment transport along the lakeshore. If this occurred, it would create the need for increased dredging activities at the harbor. Additional studies and/or monitoring would be needed to evaluate the potential for this effect.

Transporting sediment from an updrift to a downdrift location would mimic the natural processes, as the material used would remain within the Lake Michigan system, resulting in moderate, long-term, beneficial impact. Potential issues with sedimentation at the Burns Waterway Small Boat Harbor would need to be evaluated, and would result in a minor to moderate, long-term, adverse impact.

Dune Formation Processes. Under alternative C-5, the five-year quantity of sediment to be placed on the beach in reach 3 would occur via dredging from an updrift location in Lake Michigan, such as near the NIPSCO/Bailly intake. This sediment would erode over the course of approximately five years. Placement of the sediment would provide additional material available on land

for aeolian transport, thus encouraging foredune development. Placing the five-year quantity of sediment on the beach would result in additional protection against storm events. The additional sediment would protect the current shoreline profile from increased erosion resulting from intense wave action, particularly during winter weather. Implementing alternative C-5 would result in moderate to major, long-term, beneficial impacts, as the additional quantity of material on the beach, in conjunction with wind action, would encourage foredune development. The additional quantity of material would also provide buffering against intense weather events.

Cumulative Impacts. Cumulative impacts under alternative C-5 would generally be as described for alternative A, with the exception that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. The initial large amount of material placed on the beach would enhance conditions for dune formation, and provide greater protection to the beach complex from storm events. Cumulative effects would be negligible, long-term and adverse.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 3 every five years would mitigate the sediment budget deficit and protect the current shoreline profile. Actions associated with alternative C-5 would also provide a large quantity of sediment on the beach from an updrift source to facilitate foredune development along the shoreline, resulting in moderate, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible, long-term and adverse. There would also be potential increased sedimentation at Burn's Waterway Small Boat Harbor.

Actions under alternative C-5 would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

Alternative D (Beach Nourishment via Permanent Bypass System)

Sediment Transport Processes. Under alternative D, the amount of sediment material deposited in reach 3 would fulfill the estimated sediment budget deficit. A permanent bypass system would be constructed and operated to transport sediment from updrift of the NIPSCO/Baily complex to Portage Lakefront and Riverwalk. As with the previously described alternatives, implementing alternative D would place the additional sediment on the beach in reach 3. This would result in an initial increase in beach size within the placement area in front of Portage Lakefront and Riverwalk. The additional nourishment material would be sufficient to maintain the current shoreline position for approximately one year, as natural wave action would continue to erode the sediment after placement. The shoreline downdrift of Portage Lakefront and Riverwalk would receive an infusion of sediment following the material placement, affecting not only reach 3, but also reach 4.

Transporting sediment from an updrift to a downdrift location in this manner would mimic natural processes as material used in nourishment would remain within the Lake Michigan system, resulting in moderate, long-term, beneficial impacts.

Dune Formation Processes. Under alternative D, the amount of sediment material deposited in reach 1 would fulfill the estimated sediment budget deficit. A permanent bypass system would be constructed and operated to transport sediment from updrift of the NIPSCO/Baily complex to Portage Lakefront and Riverwalk under this alternative. This sediment deposit would erode over the course of approximately one year. Placement of sediment on the beach is more effective than nearshore placement as additional material is available for aeolian

transport, thus encouraging foredune development. Beach placement would provide some buffering against storm events. The additional sediment on the beach would protect the current shoreline profile from increased erosion resulting from intense wave action, particularly during storm events.

Implementing alternative D would result in moderate, long-term, beneficial impacts, as the sediment placed on the beach, in conjunction with wind action, would provide additional sediment supply to create foredunes.

Cumulative Impacts. Cumulative impacts for alternative D would generally be as described for alternative A, with the exception that beach nourishment activities would include the amount of sediment needed to balance the annual sediment budget deficit. Cumulative impacts would be negligible to minor, long-term and adverse.

Conclusion. Placing the proposed quantity of sediment on the beach in reach 3 would mitigate the sediment budget deficit, and thereby maintain the current shoreline profile. Additionally, dredging sediment from an updrift location would more closely mimic natural processes as compared to using material from upland sources. The actions associated with alternative D would also provide additional sediment to encourage foredune development along the shoreline, resulting in moderate, long-term, beneficial impacts on coastal processes. Cumulative impacts on coastal process would be negligible to minor, long-term and adverse.

Actions under alternative D would provide incremental beneficial increases to the overall adverse cumulative impacts described under alternative A. Despite these actions, existing navigational and industrial structures along the lakeshore would continue to disrupt the natural littoral drift along the lakeshore.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current and Proposed Management Actions

Current and proposed management actions for the foredune and dune complex address the issues of sensitive habitat restoration, invasive vegetation management, and anthropogenic influences. These actions primarily affect terrestrial resources. Management actions that would result in dune stabilization, such as revegetation with native plants and protection from pedestrian overuse (e.g., the realignment of trails), would encourage the dune formation processes. Also, as sediment is transported between the nearshore, beach, and dune complexes, improved conditions in the foredune and dune complex would enhance the natural sediment transport processes between these complexes. These actions would result in minor, long-term, beneficial impacts on coastal processes.

Cumulative Impacts. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under coastal processes as a result of proposed management actions would be negligible to minor, long-term, and beneficial from the enhanced natural sediment transport process that would result from the improved conditions in the foredune and dune complex.

Conclusion. Addressing sensitive habitat issues in the foredune and dune complex through site restoration, invasive vegetation management, and limiting and managing anthropogenic influences would result in dune stabilization from enhanced natural sediment transport processes, resulting in minor, long-term, beneficial impacts. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under coastal processes would be negligible to minor, long-term, and beneficial from the enhanced natural sediment transport process that would result from the improved conditions in the foredune and dune complex.

AQUATIC FAUNA

METHODOLOGY

This analysis incorporates the best available scientific literature applicable to the region, the setting, and the actions being considered in the alternatives. Available information describing native, invasive and nonnative aquatic communities and distribution, including published scientific papers, NPS research reports, planning documents, state program materials, national databases and mapping efforts, and consultation with park specialists, were gathered, reviewed, and summarized. Impacts on aquatic fauna were evaluated by comparing projected changes resulting from the action alternatives to the projected results of implementing the no-action alternative.

Intensity Level Definitions

Intensity thresholds for native aquatic fauna are defined as follows:

Negligible: The impact is barely detectable, and/or would result in no noticeable or perceptible changes in encouraging native aquatic fauna presence.

Minor: The impact is slight but detectable, and/or would result in small but noticeable changes in encouraging native aquatic fauna presence.

Moderate: The impact is readily apparent, and would result in easily detectable changes in encouraging native aquatic fauna presence.

Major: The impact is severely adverse, or exceptionally beneficial, and/or would result in appreciable changes in encouraging native aquatic fauna presence.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

Alternative A (No-action Alternative)

Storm waves, capable of reaching the base of coastal dunes, cause massive erosion and slumping of dune sands. This, in turn, introduces large volumes of sediment into the nearshore sediment transport system. Fine dune sediment is held in suspension much longer than beach sediment or fill sediment, and could therefore, be transported farther offshore. Suspended solids in the water could affect fish populations by delaying the hatching time of fish eggs, killing the fish by abrading their gills, and causing anoxia. Fish tolerance to suspended solids varies from species to species and by age; however, destruction of habitat rather than suspension of sediments appears to be the major hazard to beach and nearshore fish. Most of these aquatic species have the ability to migrate from an undesirable environment and return when deposition ceases. Benthic fish (those living on or near the bottom of the lake) move into an area within the first day after a disturbance ceases. The motile aquatic species, that have stringent environmental requirements, such as substrate preferences for spawning, foraging, or shelter, as well as species closely associated with the beach for part of their life cycle (e.g., longnose dace [*Rhinichthys cataractae*]), would be most likely affected by beach nourishment (COE 1989). Species that form lake-bottom or benthic communities on most high-energy coastal beaches are adapted to periodic changes related to the natural erosion and accretion cycles and storms. Organisms adapted to unstable nearshore bottom conditions tend to tolerate perturbations better than those in more stable offshore environments. Areas of continued erosion and accretion would disturb spawning and nursery habitats in the nearshore.

Potential effects of beach nourishment include: altered distribution during offshore nourishment; potential for gill clogging and abrasion; temporary smoldering of benthic prey; burial of areas that serve as foraging and shelter sites; and potential burial of benthic fish. Burial of offshore benthic animals by beach nourishment material has a greater potential for adverse effects because the offshore organisms are more sensitive to perturbation than those in the upper nearshore and swash zone. Direct burial of nonmotile aquatic species in the placement area would produce localized mortality but would not have an appreciable effect of population stability (COE 1989).

Under alternative A, the natural processes occurring in the lake, though exacerbated by the modifications along the shoreline, would continue to provide nearshore habitat for the most disturbance-tolerant species. It is assumed that beach nourishment activities would continue, averaging approximately 31,500 yd^3 of mined material placed annually along the shoreline around Crescent Dune near Mount Baldy.

Meiofauna and Macroinvertebrates — A 2006 study conducted in association with the current beach nourishment activities indicated that the benthic community affected by material deposition near Mount Baldy showed evidence of a relatively high rate of recovery within eight to 12 months after beach nourishment activities. Densities and total number of benthic taxa increased with depth, suggesting lower impact of sediment drift and wave action in deeper waters (Przybryla-Kelly and Whitman 2006). Since the benthic community within the beach nourishment placement area would recover within a year, impacts on the benthic community under the no-action alternative would be minor, short-term and adverse.

Fish of Lake Michigan — Yellow perch (*Perca flavescens*), as well as other fish species, are frequently found in the nearshore area, where wave-induced sediment transport is naturally active. It is well-recognized that these fish would vacate this nearshore area whenever a temporary natural disturbance occurred (e.g., the passage of a storm resulting in high wave activity and suspension of large quantities of sediment) and would return when favorable conditions were again present. Under the no-action alternative, the yellow perch population in the nearshore would be subjected to environmental stress arising from erosion and suspension of fine dune sands. The current beach nourishment program conducted by the COE was designed to combat this erosion. The average 31,500 yd^3 of material placed annually would be less than the calculated sediment budget deficit of 136,500 yd^3. Annual beach nourishment results in temporary displacement of fish as turbidity in the water column in both the dredge location and placement area would render the nearshore temporarily inhospitable. Under the no-action alternative, the erosion along the shoreline would continue, and fish assemblages in the nearshore area would remain subjected to environmental stress. Impacts on native fish species under alternative A would be minor, short-term and adverse.

Invasive and Nonnative Species — The presence of invasive and nonnative species, including round gobies and dreissenid mussels, changes native species composition. Dreissenid mussels compete directly with zooplankton for food because they filter phytoplankton from the water column. The decrease in zooplankton densities indirectly results in reduced numbers of age-0 yellow perch. Under the no-action alternative, beach nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. This is because the sandy substrate of the lakeshore provides for benthic species and fish assemblages intertwined in a delicate food web that is easily disrupted by external forces, such as beach nourishment and placement activities like those currently taking place in reach 1. The sediment material used for such beach nourishment could provide a pathway for the establishment and introduction of nonnative species. Sediment

placement activities could also cause an unequal distribution of sediment supply to the lakeshore, resulting in a disturbed environment for aquatic fauna that encourages or invites nonnative and invasive species. The continued high rate of erosion taking place under the no-action alternative would result in loss of nearshore habitat, thus displacing native fish communities and encouraging a disturbed environment potentially more conducive to the presence of invasive and nonnative species. Effects on native species from the introduction and establishment of invasive and nonnative species would be negligible, long-term and adverse.

Cumulative Impacts. Several potential actions, independent of this plan, would affect the park's aquatic fauna. As described in the "Affected Environment" chapter, anthropogenic influences and alterations to the natural lake habitat have affected native aquatic species. The COE's electric barrier currently helps to block the passage of aquatic nuisance species between the Great Lakes and Mississippi River basins and beneficially discourages the presence of invasive and nonnative aquatic fauna. In the future, additional modifications to the nearby industrial and other properties may be made, which may affect the benthic community and fish assemblages along the Lake Michigan shoreline. Additionally, permitting requirements for industrial and federal discharges into the lake may change, becoming stricter or more lax. Ongoing river projects, like the Calumet Harbor and River project and its associated dredging activities and support of transit in the Great Lakes, may lead to future introductions of aquatic invasive species and continued disturbance to aquatic habitat. Additionally, ships' ballast water, which has accounted for 55% to 70% of reported aquatic invasive species introductions in to the Great Lakes since 1959, continues to provide a pathway for aquatic invasive species in to the Great Lakes. However, future introductions of aquatic invasive species may be effectively managed through ballast water exchange, saltwater flushing, or shipboard treatment, and through restricting access to the Great Lakes to vessels that have not taken protective measures to ensure they do not harbor aquatic invasive species.

Overall, these combined actions would have a moderate, long-term, adverse impact on the native aquatic species from disturbances to the natural lake habitat and from the pathways these activities introduce for aquatic invasive species. When combined with other past, present, and reasonably foreseeable future actions, implementing the no-action alternative would provide no incremental addition to the overall cumulative impacts on aquatic fauna.

Conclusion. Under the no-action alternative, nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. In addition, the 31,500 yd^3 of nourishment material would not be sufficient to address the sediment deficit and beach erosion would continue. The actions proposed under the no-action alternative would result in negligible to minor, short- and long-term, adverse impacts on the native aquatic species. The overall cumulative impacts from invasive and nonnative aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under the no-action alternative, there would be no incremental addition to the overall cumulative impacts from disturbances to the nearshore lake habitat.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)

Under alternative B-1, the general effects of nourishment activities would be similar to those described under the no-action alternative. Under alternative B-1, nourishment activities would consist of 136,500 yd^3 of mined nourishment material being placed at Crescent Dune.

Meiofauna and Macroinvertebrates — Under alternative B-1, impacts on benthic communities would be similar to those described under the no-action alternative, except that onshore placement of 136,500 yd^3 of beach nourishment material would temporarily smother benthic fauna at the placement location, which would consist of a greater area. As beach nourishment material would be from upland sources, there would be no disturbance to the aquatic habitat from dredging activities. In addition, the nourishment volume would match the sediment budget deficit and alleviate the adverse effects from erosion, thereby enhancing the aquatic habitat of the benthic communities. There would be fewer adverse effects from erosion of the shoreline, but the footprint of burial of benthic communities would be larger. Overall effects on the benthic community would be minor, short- and long-term, adverse and beneficial.

Fish of Lake Michigan — Under alternative B-1, effects on fish species would be similar to those described under the no-action alternative, except that under alternative B-1 there would be less erosion and less associated environmental stress to spawning and nursery habitats. Overall effects on fish species would be minor, long-term and beneficial because there would be less environmental stress from erosion and no disturbance from dredging. Under alternative B-1, the volume of beach nourishment material placed on reach 1 would cover a larger area and require longer placement times (approximately four months every year) than under the no-action alternative, resulting in a longer duration of turbid waters and thus longer periods of environmental stress for aquatic fauna. This annual beach nourishment would temporarily displace fish and result in minor, short-term, adverse effects on fish species.

Invasive and Nonnative Species — Invasive and nonnative aquatic species located in the nearshore of Lake Michigan would be affected similar to the native fish species. A largely homogenous sandy substrate would make the nearshore environment desirable to not only the native species, but to the invasive and nonnative aquatic species as well. Disruption of the natural environment typically would allow for introduction and establishment of nonnative and invasive species. Under alternative B-1, beach nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. This is because the sandy substrate of the lakeshore provides for benthic species and fish assemblages that are easily disrupted by external forces, such as the beach nourishment activities that would take place under alternative B-1. Sediment placement activities could cause an unequal distribution of sediment supply to the lakeshore, resulting in a disturbed environment for aquatic fauna that would encourage or invite nonnative and invasive species. Appropriate beach nourishment material would be used, which would help mitigate attracting nonnative species. Therefore, under alternative B-1, effects from encouraging the presence of invasive and nonnative aquatic fauna would be similar to those described under the no-action alternative, except that over 105,000 yd^3 of additional beach nourishment material would be distributed on the beach. Impacts from invasive and nonnative aquatic species under alternative B-1 would be negligible, long-term and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect aquatic fauna would be similar to those described under the no-action alternative; moderate, long-term and adverse. Under alternative B-1, nourishment activities would beneficially add to the cumulative, long-term impacts. When combined with other past, present, and reasonably foreseeable future actions, implementing alternative B-1 would incrementally provide a beneficial effect from reducing erosion in the area, and a slight addition to the adverse effects from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative B-1 would result in negligible to minor, short- and long-term, adverse and beneficial impacts on the native aquatic species. The fish assemblages in the nearshore would be temporarily displaced and benthic communities would be smothered during beach nourishment activities. Also, nourishment activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species, but overall the decreased erosion in the area would benefit benthic communities. The overall cumulative effects on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under alternative B-1, there would be a slight incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)

Meiofauna and Macroinvertebrates — Under alternative B-5, effects on the benthic community would be similar to those under alternative B-1. Placement of 682,500 yd^3 of sediment along the length of reach 1, would reduce erosion in the area, but would also smother benthic fauna within a greater footprint than under alternative B-1 and would last approximately 18 months every five years. The appropriate sediment placed during beach nourishment activities, in conjunction with effective timing, design and deposition rate, would reduce the adverse effects. Nonetheless, under alternative B-5, increasing the footprint of the placement area would result in burial of the benthic fauna along most of reach 1. The impacts under alternative B-5 would be moderate, long-term and adverse from smothering benthic communities, and minor, long-term and beneficial from reducing erosion.

Fish of Lake Michigan — Under alternative B-5, effects on fish species would be similar to those described under alternative B-1. Placement of 682,500 yd^3 of sediment along the length of reach 1 every five years would reduce erosion in the area, but would also displace fish and interrupt fish life cycles until turbidity in the water column subsided such that the area was once again inhabitable. Water turbidity would last for a longer period of time under alternative B-5 than under alternative B-1 because of the larger area of placement and the longer duration (approximately 18 months every five years) of placement activities. Therefore, under alternative B-5, impacts on fish species would be moderate, long-term and adverse from displacement due to water turbidity, and minor, long-term and beneficial from reducing erosion in the area and enhancing the fish habitat.

Invasive and Nonnative Species — Under alternative B-5, both native and nonnative/invasive benthic species would be temporarily affected by burial. Disruption of the natural environment would allow for introduction and establishment of nonnative and invasive species. Under alternative B-5, beach nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. This is because the sandy substrate of the lakeshore provides for benthic species and fish assemblages that are easily disrupted by external forces, such as the beach nourishment activities that would take place under alternative B-5. Sediment placement activities could cause an unequal distribution of sediment supply to the lakeshore, resulting in a disturbed environment for aquatic fauna that would encourage or invite nonnative and invasive species. Risks from attracting nonnative species would be minimized because appropriate grain sized material would be used. Therefore, under alternative B-5, the effects from encouraging invasive and

nonnative aquatic fauna would be negligible, long-term and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under alternative B-5, beach nourishment activities would incrementally add to the cumulative long-term impacts. When combined with other past, present, and reasonably foreseeable future actions, implementing alternative B-5 would provide an incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative B-5 would result in negligible to moderate, long-term, adverse and beneficial impacts on the native aquatic species. The fish assemblages in the nearshore would be temporarily displaced and benthic communities would be smothered during beach nourishment activities. Also, beach nourishment activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species. Overall, the decreased erosion in the area would benefit benthic communities. The overall cumulative effects on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under alternative B-5, there would be a slight incremental addition to the overall adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Meiofauna and Macroinvertebrates — The effects on benthic communities under alternative C-1 would be similar to those described under alternative B-1 except that 136,500 yd^3 of beach nourishment material would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, and placed annually on the beach in reach 1.

Some research has shown that that the high-pressure (dredge) pipe kills most soft-bodied infaunal organisms, and animals that survive suspension only play a minor role in re-colonization. To enhance the chance of survival, sediment would closely match the native beach and would be applied slowly in a sheeting spray of sediment and water. This would allow organisms to keep up with the sediment overburdens as they were applied. As previously mentioned, literature reviews of beach nourishment impacts on beach biota indicate short-term declines in abundance, biomass, and taxa richness following beach nourishment. Recovery of the benthic community within the nearshore environment has been shown to occur within eight to 12 months after nourishment activities. Additionally, densities and total number of benthic taxa increased with depth, suggesting lower impact of sediment drift and wave action in deeper waters (Przybryla-Kelly and Whitman 2006).

Under alternative C-1, annual beach nourishment of the park shoreline with dredged material deposited onto the beach would have minor, short- and long-term, adverse and beneficial impacts on the benthic community in the placement area. There would be a long-term, beneficial effect from reducing erosion of the shoreline, but dredge activities would kill individual soft-bodied infaunal organisms. A high rate of recovery of the benthos would be expected in less than one year.

Fish of Lake Michigan — The effects on fish species under alternative C-1 would be similar to those described under alternative B-1 except that beach nourishment material would be dredged and pumped along reach 1. The turbidity in the water column would last longer because the volume of beach nourishment material placed on reach 1 under alternative C-1 would cover a larger area and require longer placement times (approximately two months every year) than under the no-action alternative. This annual beach nourishment activity would temporarily displace fish and result in minor, short-term, adverse effects. Overall effects on fish species would be minor, long-term and beneficial because there would be less environmental stress from erosion.

Invasive and Nonnative Species — Dredging activities under alternative C-1 would disturb the natural environment and allow invasive and nonnative aquatic fauna to become established. Under alternative C-1, beach nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. This is because the sandy substrate of the lakeshore provides for benthic species and fish assemblages that are easily disrupted by external forces, such as beach nourishment, placement, and dredging activities like those that would take place under alternative C-1. Sediment placement activities could also cause an unequal distribution of sediment supply to the lakeshore, resulting in a disturbed environment for aquatic fauna that would encourage or invite nonnative and invasive species. The dredged material would be similar in grain size distributions to those of the native beach and the grain size would closely match that of the natural beach sediments. Under alternative C-1, effects from encouraging the presence of invasive and nonnative aquatic fauna would be similar to those described under alternative B-1: negligible, short-term and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under alternative C-1, beach nourishment activities would beneficially add to the cumulative, long-term impacts. When combined with other past, present, and reasonably foreseeable future actions, implementing actions under alternative C-1 would provide a slight incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative C-1 would result in negligible to minor, short- and long-term, adverse and beneficial impacts on the native aquatic species. The fish assemblages in the nearshore would be temporarily displaced and benthic communities would be smothered during beach nourishment activities. Also, nourishment and dredging activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species, but overall the decreased erosion in the area would benefit benthic communities. The overall cumulative effects on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under alternative C-1, there would be a slight incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)

Meiofauna and Macroinvertebrates — Under alternative C-5, effects on the benthic community would be similar to those under

alternative C-1. Placement of 682,500 yd^3 of sediment on the beach in reach 1 every five years would reduce erosion in the area, but would also smother benthic fauna within a greater footprint than under alternative C-1 and there would be greater mortality to individual soft-bodied infaunal organisms. The impacts under alternative C-5 would be moderate to major, short- and long-term, and adverse from dredging activities and smothering benthic communities, and minor, long-term and beneficial from reducing the effects of erosion.

Fish of Lake Michigan — Under alternative C-5, effects on fish species would be similar to those under alternative C-1. Placement of 682,500 yd^3 of sediment along the length of reach 1 every five years would reduce erosion in the area, but would also displace fish and interrupt fish life cycles until turbidity in the water column subsided such that the area was once again inhabitable. Water turbidity would last for a longer period of time under alternative C-5 than under alternative C-1 because of the larger area of placement and the longer duration (approximately 10 months every five years) of dredging and placement activities. Therefore, under alternative C-5, impacts on fish species would be moderate to major, short- and long-term, and adverse from displacement due to water turbidity and dredging activities, and minor, long-term and beneficial from reducing erosion in the area and enhancing the fish habitat.

Invasive and Nonnative Species — Dredging activities under alternative C-5 would further disturb the natural environment, more so than under alternative C-1, and allow for the establishment of invasive and nonnative aquatic fauna. Therefore, under alternative C-5, effects from encouraging the presence of invasive and nonnative aquatic fauna would be negligible, short-term, and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under alternative C-5, beach nourishment activities would beneficially add to the long-term, cumulative impacts. When combined with other past, present, and reasonably foreseeable future actions, implementing actions under alternative C-5 would provide a slight incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative C-5 would result in negligible to major, short- and long-term, adverse and beneficial impacts on native aquatic species. The fish assemblages in the nearshore would be temporarily displaced and benthic communities would be smothered during beach nourishment activities. Also, beach nourishment and dredging activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species, but overall the decreased erosion in the area would benefit benthic communities. The overall cumulative effects on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under alternative C-5, there would be a slight incremental addition to the overall adverse, short-term, cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Alternative D (Beach Nourishment via Permanent Bypass System)

Meiofauna and Macroinvertebrates — Under alternative D, on average, a total of 136,500 yd^3 of sediment would be transported via a permanent bypass system annually from updrift of the Michigan City Harbor to reach 1. The effects of implementing the high-pressure line associated with the permanent bypass system would be similar to those

described under alternative C-1. There would be a minor, long-term, beneficial effect from reducing erosion of the shoreline, but the bypass system would kill individual soft-bodied infaunal organisms and cause minor, short-term impacts on benthic communities. Therefore, nourishment of the park shoreline with a sediment bypass system would have minor, short- and long-term, adverse and beneficial impacts on the benthic community in the placement area.

Fish of Lake Michigan — Under alternative D, the effects on fish species would be similar to those described under alternative C-1 except that beach nourishment material would be pumped via a permanent bypass system. Implementing this beach nourishment system would result in temporary displacement of fish and produce minor, short-term, adverse effects. Overall effects on fish species would be minor, long-term and beneficial because there would be less environmental stress from erosion.

Invasive and Nonnative Species — The construction of the permanent bypass system would temporarily disrupt the natural environment and allow for the introduction of invasive and nonnative species. Invasive species, particularly round gobies and zebra mussels, would be attracted to artificial structures within the nearshore environment. There would be a slight change in the attraction of invasive and nonnative aquatic fauna. Under alternative D, effects from encouraging the presence of invasive and nonnative aquatic fauna would be negligible, long-term and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect invasive and nonnative aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under alternative D, beach nourishment activities and the permanent bypass system would incrementally add to the long-term, cumulative impacts. When combined with other past, present, and reasonably foreseeable future actions, actions under alternative D would provide an incremental addition to the overall adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative D would result in negligible to minor, short- and long-term, adverse and beneficial impacts on native aquatic species. The fish assemblages in the nearshore would be temporarily displaced and benthic communities would be smothered during beach nourishment activities. Also, construction of a permanent bypass system would disrupt the nearshore environment and allow for the introduction and establishment of invasive and nonnative species. Overall, the decreased erosion in the area would benefit benthic communities. The overall cumulative effects on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under alternative D, there would be a slight incremental addition to the overall adverse cumulative impacts from smothering benthic communities, displacing fish species and encouraging the presence of invasive and nonnative aquatic fauna with the installation of a permanent bypass system.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative

Meiofauna and Macroinvertebrates — The sandy substrate along the nearshore of the park shoreline supports a limited benthic community of low diversity. Increased densities have been noted in intermittent beds of cobble/gravel material. In the relatively high wave energy nearshore environment, at certain sediment-starved areas along the shoreline, particularly at the base of Mount Baldy, the clay substrate naturally found beneath the sediment has been exposed, and organic matter often found in

calmer waters has been carried away from the shoreline (Garza and Whitman 2004). The kinetic nature of the nearshore environment has therefore created low density and diversity within the benthic community. One study, conducted from 1996 to 1998 in conjunction with a COE beach nourishment program, indicated that relatively few species were detected in the benthic community inhabiting sandy substrates in the nearshore area, as indicated by the Shannon-Wiener and Margalef's diversity indices (Horvath *et al.* 1999).

The use of a submerged cobble berm in reach 1 would result in a longer retention of sediment within the nearshore. As the submerged cobble berm would begin to dissipate after construction, the aggregate material would disperse along the lakebed, creating a substrate inhabitable for benthic organisms. The nearshore environment at the base of Mount Baldy is currently identified with a lower benthic diversity and density as compared to other areas along the park shoreline (Garza and Whitman 2004). The implementation of alternative E within reach 1 would result in effects similar to those described under alternative C-1 because the submerged cobble berm would be used in conjunction with a beach nourishment program to restore reach 1 of Indiana Dunes National Lakeshore. These effects would be minor, short-term and adverse as the benthic fauna would be smothered during placement of the sediment. Impacts would be localized to the placement and construction area. There would be moderate, long-term and beneficial effects on the benthic community as the cobble material would both create additional habitat for these aquatic species and reduce erosion in the area. Longer retention of sediment and some organic material would allow for those species historically present in this area to re-colonize the area.

Fish of Lake Michigan — Under the preferred alternative, the nearshore environment would be disrupted not only during the beach nourishment activities, but also during construction and placement of the submerged cobble berm, and during subsequent nourishment activities. The reduced quantity of beach nourishment material deposited annually in reach 1 would make the nearshore environment desirable to native species and invasive and nonnative aquatic species alike. The effects of the annual placement of nourishment material would be similar to those described under alternative C-1.

As is the case with the benthic community in the nearshore, the presence of a submerged cobble berm in reach 1 would eventually provide a habitat for additional fish species not currently present in that area. In the initial years after construction during which the submerged cobble berm would be largely intact, wave energy would be dissipated, resulting in a calmer nearshore environment. Sediment retention time would increase, as would organic material and benthic organisms; both would be food sources for a variety of fish species. After the submerged cobble berm spread along the lake bottom, the aggregate material would potentially allow for more fish nurseries as the interstitial spaces would provide protection.

Ultimately, the implementation of the preferred alternative would result in minor, short-term, adverse impacts as fish would be temporarily displaced during construction and beach nourishment activities. However, moderate, long-term, beneficial impacts would also result as the cobble material would enhance the aquatic fauna habitat.

Invasive and Nonnative Species — Invasive species, particularly round gobies and zebra mussels, would be attracted to artificial structures within the nearshore environment. Under the preferred alternative, beach nourishment activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species. Construction of the submerged cobble berm would also further attract invasive species. The cobble material and associated interstitial spaces in the submerged cobble berm would be an attractive habitat for invasive and nonnative

species until the material dissipates and becomes covered by sediment. After the aggregate material dispersed along the lake bottom, zebra mussels' attraction to it would be minimized; however, additional invasive and nonnative aquatic species, such as the round goby, would continue to inhabit the area. Therefore, under the preferred alternative, the introduction of the submerged cobble berm into the nearshore environment would result in minor, long-term, adverse effects from encouraging invasive and nonnative aquatic fauna.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under the preferred alternative, nourishment activities and the submerged cobble berm would incrementally add both minor, short-term, adverse and minor, long-term, beneficial effects on cumulative impacts. When combined with other past, present, and reasonably foreseeable future actions, actions under the preferred alternative would provide an incremental addition to the overall cumulative impacts by enhancing the habitat for benthic communities. These effects would be slightly countered by the enhancement of habitat for invasive and nonnative aquatic fauna as well.

Conclusion. The actions proposed under the preferred alternative would result in moderate, short- and long-term, adverse and beneficial impacts on the native aquatic species. The aquatic fauna in the nearshore would be temporarily disturbed or displaced during construction of the submerged cobble berm and during beach nourishment activities. Long term, the aquatic habitat would be enhanced by providing protection and food sources for a variety of fish. The habitat would also be enhanced for nonnative and invasive species. The overall cumulative impacts on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under the preferred alternative, there would be an incremental addition to the overall cumulative effects by enhancing the habitat for benthic communities. These effects would be slightly countered by the enhancement of habitat for invasive and nonnative aquatic fauna as well.

SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Alternative A (No-action Alternative)

Storm waves, capable of reaching the base of coastal dunes, cause massive erosion and slumping of dune sands. This, in turn, causes large volumes of fine sand to be carried into the nearshore sediment transport system. Fine dune sand is held in suspension much longer than natural beach sediment or fill sediment and could, therefore, be transported farther offshore. Suspended solids in the water could affect fish populations by delaying the hatching time of fish eggs, killing the fish by abrading their gills, and causing anoxia. Fish tolerance to suspended solids varies from species to species and by age. Destruction of habitat rather than suspension of sediments appears to be the major hazard to beach and nearshore fishes. Most of these aquatic species have the ability to migrate from an undesirable environment and return when turbidity levels in the water column have decreased, and living conditions are once again present. Several long-term studies have shown that moderate to complete recovery of motile animal populations has occurred in less than a year. These studies have shown that motile aquatic species generally temporarily depart an area disturbed by beach nourishment, but return when the physical disturbance ceases. Benthic fish move into an area within the first day after a disturbance. The motile aquatic species that have stringent environmental requirements, such as substrate preferences for spawning, foraging, or shelter, are most likely to be affected (COE 1989). Therefore, species that are closely associated with the beach for part of their life cycle are most affected by beach nourishment (COE 1989). Species that form lake-bottom or

benthic communities on most high-energy coastal beaches are adapted to periodic changes related to the natural erosion and accretion cycles and storms. Organisms adapted to unstable nearshore bottom conditions tend to tolerate perturbations better than those in more stable offshore environments.

Potential effects of beach nourishment include: altered distribution during offshore nourishment; potential for gill clogging and abrasion; temporary smoldering of benthic prey; burial of areas that serve as foraging and shelter sites; and potential burial of benthic (living on or near the bottom of the lake) fish. Burial of offshore benthic animals by beach nourishment material has a greater potential for adverse effects because the offshore organisms are more sensitive to perturbation than those in the upper nearshore and swash zone. Direct burial of nonmotile aquatic species in the placement area could be lethal to the individual. Effects of direct burial of aquatic fauna are not generally substantial at the population or community level, unless it is a sensitive resource (COE 1989).

Under alternative A, the natural processes occurring in the lake, though exacerbated by the modifications along the shoreline, would continue to provide nearshore habitat for the most disturbance-tolerant species. Beach nourishment activities would consist of 74,000 yd^3 of dredged material placed within open water between 12 and 18 feet of water depth near reach 3.

Meiofauna and Macroinvertebrates — The lake substrate in reach 3 is largely homogenous and composed of sand; there is relatively little diversity and low density of benthic fauna. Under the no-action alternative, erosion would continue at an accelerated rate which would threaten the aquatic nearshore environment. As wave dynamics in this area are such that only the most disturbance-prone organisms could survive, the benthic community would remain affected by natural processes. The nearshore placement of dredged sediment would result in minor, short-term, adverse impacts on the benthic fauna in the nearshore as they would be smothered during placement of sediment. Impacts would be localized to the placement area.

Fish of Lake Michigan — Without nourishment material on the beach, the fish population in the nearshore would be subjected to an adverse environmental stress, arising from the erosion and suspension of fine dune sands. The current nearshore placement conducted by the COE was designed to combat the continued erosion of the shoreline along Portage Lakefront and Riverwalk. Erosion along the shoreline would continue, and fish assemblages in the nearshore would continue to be subjected to the environmental stress associated with erosion in the area. Nearshore nourishment placement would temporarily displace fish, as turbidity in the water column of the placement area would render the nearshore temporarily inhospitable. Impacts on native fish species under alternative A would therefore be minor, short-term and adverse.

Invasive and Nonnative Species —Under the no-action alternative, beach nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. This is because the sandy substrate of the lakeshore provides for benthic species and fish assemblages intertwined in a delicate food web that is easily disrupted by external forces, such as beach nourishment and placement activities like those currently taking place in reach 3. The sediment material used for such beach nourishment could provide a pathway for the establishment and introduction of nonnative species. Sediment placement activities could also cause an unequal distribution of sediment supply to the lakeshore, resulting in a disturbed environment for aquatic fauna that encourages or invites nonnative and invasive species. Under the no-action alternative, the effects on native populations from encouraging the presence of invasive and

nonnative species would be negligible, short-term and adverse.

Cumulative Impacts. Several potential actions, independent of this plan, would affect the park's aquatic fauna. As described in the "Affected Environment" chapter, anthropogenic influences and alterations to the natural lake habitat have affected native aquatic species. The COE's electric barrier currently helps to block the passage of aquatic nuisance species between the Great Lakes and Mississippi River basins and beneficially discourages the presence of invasive and nonnative aquatic fauna. In the future, additional modifications to nearby industrial and other properties may be made, which may affect the benthic community and fish assemblages along the Lake Michigan shoreline. Additionally, permitting requirements for industrial and federal discharges into the lake may change, becoming stricter or more lax. Ongoing river projects, like the Calumet Harbor and River project and its associated dredging activities and support of transit in the Great Lakes, may lead to future introductions of aquatic invasive species in the Great Lakes and continued disturbance to aquatic habitat. Additionally, ships' ballast water, continues to provide a pathway for aquatic invasive species in to the Great Lakes. However, future introductions of aquatic invasive species may be effectively managed through ballast water exchange, saltwater flushing, or shipboard treatment, and through restricting access to the Great Lakes to vessels that have not taken protective measures to ensure they do not harbor aquatic invasive species.

Overall, these combined actions would have a moderate, long-term, adverse impact on the native aquatic species from disturbances to the natural lake habitat and from the pathways these activities introduce for aquatic invasive species. When combined with other past, present, and reasonably foreseeable future actions, implementing the no-action alternative would provide no incremental addition to the overall cumulative impacts on aquatic fauna.

Conclusion. Under the no-action alternative, beach nourishment activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species. In addition, the 74,000 yd^3 of beach nourishment material placed in open water would not alleviate beach erosion in the area. The actions proposed under the no-action alternative would result in negligible to minor, short-term, adverse impacts on native aquatic species. The overall cumulative impacts on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under the no-action alternative, there would be no incremental addition to the overall existing cumulative impacts.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Under alternative C-1, the general effects of beach nourishment activities would be similar to those described under the no-action alternative. Under alternative C-1, nourishment activities would consist of 74,000 yd^3 of dredged beach nourishment material being placed annually on the beach at Portage Lakefront and Riverwalk.

Meiofauna and Macroinvertebrates — Under alternative C-1, impacts on benthic communities would be similar to those described under the no-action alternative, except that placement of 74,000 yd^3 of beach nourishment material would be hydraulically pumped onshore. Some research has shown that the high-pressure (dredge) pipe kills most soft-bodied infaunal organisms, and animals that survive suspension only play a minor role in re-colonization. To enhance the chance of survival, sediment would closely match the native beach and would be applied slowly in a sheeting spray of sediment and water. This would allow organisms to keep up with the sediment overburdens as they were applied. Literature reviews of beach nourishment

impacts to beach biota indicate short-term declines in abundance, biomass, and taxa richness following beach nourishment. Recovery of the benthic community within the nearshore environment has been shown to occur within eight to 12 months after nourishment activities. Additionally, densities and total number of benthic taxa increased with depth, suggesting lower impact of sediment drift and wave action in deeper waters (Przybryla-Kelly and Whitman 2006). Therefore, under alternative C-1, annual nourishment of the park shoreline with dredged material deposited onto the beach would have minor, short- and long-term, adverse and beneficial impacts on the benthic community in the placement area. There would be a minor, long-term, beneficial effect from reducing erosion of the shoreline, but the dredge would kill individual soft-bodied infaunal organisms. A high rate of recovery of the benthos would be expected within less than one year.

Fish of Lake Michigan—Under alternative C-1, effects on fish species would be similar to those described under the no-action alternative, except under alternative C-1 there would be less erosion and less associated environmental stress to spawning and nursery habitats. Effects on fish species would be minor, long-term and beneficial because there would be less environmental stress. Under alternative C-1, the volume of beach nourishment material placed on reach 3 would cover a larger area and require longer placement times (approximately two months every year) than under the no-action alternative, resulting in a longer duration of turbid waters and thus longer periods of environmental stress for aquatic fauna. This annual beach nourishment would temporarily displace fish and result in minor, short-term, adverse effects on fish species.

Invasive and Nonnative Species — Invasive and nonnative aquatic species located in the nearshore of Lake Michigan would be affected similar to the native fish species. A sandy substrate would make the nearshore environment desirable to not only the native species, but the invasive and nonnative aquatic species as well. Disruption of the natural environment typically allows for introduction and establishment of nonnative and invasive species. Under alternative C-1, beach nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. This is because the sandy substrate of the lakeshore provides for benthic species and fish assemblages that are easily disrupted by external forces, such as beach nourishment, placement, and dredging activities like those that would take place under alternative C-1. Sediment placement activities could also cause an unequal distribution of sediment supply to the lakeshore, resulting in a disturbed environment for aquatic fauna that would encourage or invite nonnative and invasive species. Appropriate beach nourishment material would be used, which would help mitigate attracting nonnative species. Therefore, under alternative C-1, effects from encouraging the presence of invasive and nonnative aquatic fauna would be similar to those described under the no-action alternative and would be negligible, short-term and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under alternative C-1, beach nourishment activities would beneficially add to the long-term, cumulative impacts by reducing erosion in the area and enhancing the aquatic habitat. When combined with other past, present, and reasonably foreseeable future actions, actions under alternative C-1 would provide a slight incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative C-1 would result in negligible to

minor, short- and long-term, adverse and beneficial impacts on native aquatic species. The fish assemblages in the nearshore would be temporarily displaced and benthic communities would be smothered during beach nourishment activities. Also, nourishment and dredging activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species, but overall the decreased erosion in the area would benefit benthic communities. The overall cumulative effects on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under alternative C-1, there would be a slight incremental addition to the short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative

Under alternative C-5, the general effects of beach nourishment activities would be similar to those described under the no-action alternative. Under alternative C-5, beach nourishment activities would consist of 370,000 yd^3 of sediment being dredged from an updrift location in Lake Michigan, such as near the NIPSCO/Bailly intake, once every five years.

Meiofauna and Macroinvertebrates — Under alternative C-5, effects on the benthic community would be similar to those under alternative C-1. Placement of 370,000 yd^3 of sediment along Portage Lakefront and Riverwalk at reach 3 once every five years would reduce erosion in the area, but would also smother benthic fauna within a greater footprint than that under alternative C-1. In addition, there would be greater mortality to individual soft-bodied infaunal organisms from the hydraulic pumping of beach nourishment material. Therefore, the impacts on benthic communities under alternative C-5 would be moderate to major, short- and long-term, and adverse due to the duration (i.e., approximately six months every five years) and extent of the beach nourishment placement, and effects from reducing erosion in the area would be minor, long-term and beneficial.

Fish of Lake Michigan — Under alternative C-5, effects on fish species would be similar to those under alternative C-1. Placement of 370,000 yd^3 of sediment every five years would reduce erosion in the area, but would also displace fish and interrupt fish life cycles until turbidity in the water column subsided such that the area was once again inhabitable. Water turbidity would last for a longer period of time under alternative C-5 than under alternative C-1 because of the larger area of placement and the longer duration (approximately six months every five years) of dredging and placement activities. Therefore, under alternative C-5, impacts on fish species would be moderate to major, short- and long-term, and adverse from displacement due to water turbidity and dredging activities, and minor, long-term, and beneficial from reducing erosion in the area and enhancing the fish habitat.

Invasive and Nonnative Species — Dredging/pumping activities under alternative C-5 would further disturb the natural environment, more so than under alternative C-1, and allow for the establishment of invasive and nonnative aquatic fauna. Under alternative C-5, beach nourishment activities would disturb the placement site, which would encourage the establishment of nonnative and invasive species at that site. Beach nourishment, placement, and dredging activities like those that would take place under alternative C-1 would disturb the aquatic fauna environment. Sediment placement activities could also cause an unequal distribution of sediment supply to the lakeshore, resulting in a disturbed environment for aquatic fauna that would encourage or invite nonnative and invasive species. Therefore, under alternative C-5,

effects from encouraging the presence of invasive and nonnative aquatic fauna would be negligible, short-term, and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect invasive and nonnative aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under alternative C-5, nourishment activities would incrementally add to the long-term, beneficial, cumulative impacts by reducing the adverse effects of erosion in the area. When combined with other past, present, and reasonably foreseeable future actions, the actions under alternative C-5 would also provide an incremental addition to the overall short-term, adverse cumulative impacts from displacing or disturbing native fish species and encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative C-5 would result in negligible to major, short- and long-term, adverse and beneficial impacts on the native aquatic species. Fish assemblages would be displaced, and fish life cycles would be interrupted. Also, beach nourishment and dredging activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative aquatic fauna. The overall cumulative impacts on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Implementing the actions under alternative C-5 would provide an incremental addition to the overall short-term, adverse and beneficial, cumulative impacts, as effects from erosion in the area would be lessened, but there would be disturbances to the aquatic communities during beach nourishment activities.

Alternative D (Beach Nourishment via Permanent Bypass System)

Meiofauna and Macroinvertebrates — Under alternative D, 74,000 yd^3 of sediment would be transported via a permanent bypass system from updrift of the NIPSCO/Bailly complex and be placed on the beach at Portage Lakefront and Riverwalk. The effects of the high-pressure line associated with the permanent bypass system would be similar to those described under alternative C-1. There would be a minor, long-term, beneficial effect from reducing erosion of the shoreline, but the bypass system would kill individual soft-bodied infaunal organisms and cause minor, short-term, adverse impacts on benthic communities. Therefore, nourishment of the park shoreline with a sediment bypass system would have minor, short- and long-term, adverse and beneficial impacts on the benthic community in the placement area.

Fish of Lake Michigan — The effects on fish species under alternative D would be similar to those described under alternative C-1, except that beach nourishment material would be pumped via a permanent bypass system. This nourishment system would temporarily displace fish, resulting in minor, short-term, adverse effects. Overall effects on fish species would be minor, long-term and beneficial because there would be less environmental stress from erosion.

Invasive and Nonnative Species — The construction of the permanent bypass system would temporarily disrupt the natural environment and allow for the introduction of invasive and nonnative species. Invasive species, particularly round gobies and zebra mussels, would be attracted to artificial structures within the nearshore environment. There would be an easily detectible change in the attraction of invasive and nonnative aquatic fauna. Under alternative D, effects from encouraging the presence of invasive and nonnative aquatic fauna would be negligible, long-term and adverse.

Cumulative Impacts. Past, present, and reasonably foreseeable future projects with the potential to affect invasive and nonnative aquatic fauna would be similar to those described under the no-action alternative: moderate, long-term and adverse. Under

alternative D, beach nourishment activities and the permanent bypass system would incrementally add to the long-term, cumulative impacts. When combined with other past, present, and reasonably foreseeable future actions, actions implemented under alternative D would provide an incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and potentially encouraging the presence of invasive and nonnative aquatic fauna.

Conclusion. The actions proposed under alternative D would result in negligible to minor, short- and long-term, adverse and beneficial impacts on native aquatic species. The fish assemblages in the nearshore would be temporarily displaced and benthic communities would be smothered during beach nourishment activities. Also, construction activities would disrupt the nearshore environment, which would allow for the introduction and establishment of invasive and nonnative species. Overall, the decreased erosion in the area would benefit benthic communities. The overall cumulative effects on aquatic fauna from past, present, and reasonably foreseeable future projects would be moderate, long-term and adverse. Under alternative D, there would be a slight incremental addition to the overall short-term, adverse cumulative impacts from smothering benthic communities, displacing fish species and encouraging the presence of invasive and nonnative aquatic fauna with the installation of a permanent bypass system.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current and Proposed Management Actions

Current and proposed management actions for the foredune and dune complex address issues with sensitive habitat restoration, invasive vegetation management, and anthropogenic influences. These are actions that primarily affect terrestrial resources. Management actions that would result in reduced erosion in the area, such as revegetation with native plants and protection from pedestrian overuse, would reduce the volume of fine sand that would carried into the nearshore sediment transport system and would thereby beneficially enhance the aquatic habitat. These actions would result in minor, long-term, beneficial impacts on aquatic fauna.

Cumulative Impacts. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under aquatic fauna as a result of proposed management actions would be negligible to minor, long-term, and beneficial from the reduced erosion in the area and reduced volume of fine sediment that would be carried into the nearshore sediment transport system, beneficially enhancing the aquatic habitat.

Conclusion. Addressing sensitive habitat issues in the foredune and dune complex through site restoration, invasive vegetation management, and limiting and managing anthropogenic influences positively affect terrestrial resources and would result in minor, long-term, beneficial impacts on aquatic fauna. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under aquatic fauna would be negligible to minor, long-term, and beneficial from the enhanced aquatic habitat.

TERRESTRIAL HABITAT

METHODOLOGY

Impacts on plant and animal terrestrial habitat were evaluated by comparing projected changes that would result from implementing the action alternatives to taking no action (i.e., the no-action alternative). Information about native terrestrial habitat in the park was compiled from site visits, publicly available research data, information from park staff, and studies of similar actions and effects. Impacts on terrestrial habitat were assessed qualitatively based on the project team's knowledge and best professional judgment.

A discussion of potential effects on wildlife necessarily involves discussion of wildlife habitat, which is primarily the vegetation communities within the park. Potential effects to terrestrial invertebrates, birds, amphibians and reptiles, and mammals are based on assessed effects to native plant communities because the park's wildlife species are directly affected by the natural abundance, biodiversity, and the ecological integrity of the vegetation that composes their habitat. Effects from noise on wildlife are addressed under the "Soundscape" section of the "Environmental Consequences" chapter.

Intensity Level Definitions

Intensity thresholds for terrestrial habitat are defined as follows:

Negligible: The impact is barely detectable and/or would result in no noticeable or perceptible changes in encouraging terrestrial habitat for plant and animal communities.

Minor: The impact is slight but detectable and/or would result in small but noticeable changes in encouraging terrestrial habitat for plant and animal communities.

Moderate: The impact is readily apparent and would result in easily detectable changes in encouraging terrestrial habitat for plant and animal communities.

Major: The impact is severely adverse or exceptionally beneficial, and/or would result in appreciable changes in encouraging terrestrial habitat for plant and animal communities.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

Alternative A (No-action Alternative)

Under the no-action alternative, there would be no new impacts on the terrestrial habitat of native plant and animal communities in the park, and the actions associated with this alternative would neither invite nor deter invasive species from inhabiting the shoreline and beach complex in reaches 1 and 2. Under this alternative, the current trend of destabilization of the foredunes would continue, increasing the risk to Mount Baldy. Such destabilization would lead to the localized loss of the natural ecosystems associated with the beach and the foredunes, including plant species endemic to the dunes, as well as insects, reptiles, birds and mammals dependent upon this habitat. These actions would have minor, short- and long-term, adverse impacts on terrestrial habitat. In addition, the western terminus of reach 1 would continue to be infested with nonnative trees. Continued erosion and degradation would invite colonization by these species and other nonnative invasive plants, having a minor, long-term, adverse impact on terrestrial habitat for native plant and animal communities.

Under the no-action alternative, current beach nourishment activities in reach 1 would forestall continued erosion and degradation around Mount Baldy. The amount of sediment added to the shoreline would be

inadequate to offset the deficit under this alternative. Therefore, the erosion and degradation of the foredune would continue, thus jeopardizing plant species endemic to the foredune complex. The actions associated with the no-action alternative would have minor, short- and long-term, adverse impacts on native plant and animal communities, as some beach vegetation would be smothered by sediment placement during beach nourishment activities and loss of critical terrestrial habitat would continue. With no new actions being taken under alternative A, storm events would continue to cause substantial erosion in the park to the detriment of terrestrial habitat for plant and animal communities.

Cumulative Impacts. Several actions, independent of this plan, would affect the park's terrestrial habitat for plant and animal communities. As described in the "Affected Environment" chapter, much of the terrestrial habitat for native plant communities in the park, including species of conservation concern, has been altered by invasive vegetation and anthropogenic influences.

The Michigan City Harbor, Port of Indiana industrial complex, and the Gary-U.S. Steel man-made structures that were constructed in and around the project area continue to interrupt natural processes with minor, long-term, adverse effects on the terrestrial habitat for native plant and animal communities because of the changes to natural sediment accumulation that these cause. The designation of the appropriate route to and from Mount Baldy from the parking lot by the park resulted in minor, long-term, beneficial impacts on native plant and animal communities by reducing the social trails in reach 1, thus reducing the trampling of native plants in this area and the introduction of invasive plant species to this reach.

Development projects, past, present, and future, like those that occurred under Phase I of the Marquette Plan and those that are proposed under Phase II of that plan, would have minor to moderate, short- and long-term, adverse impacts on native plant vegetation. Construction work often results in the loss and modification of vegetation in construction areas, and potentially introduces invasive and nonnative plant species. The spread of nonnative and invasive plant species in the park has been a problem. Pathways that could introduce nonnative and invasive plant species in to the park include construction and visitor activities, as well as natural sources such as wind and bird migration. It is difficult to determine the impact of nonnative species on native vegetation due to the uncertainties about the type of species that could be introduced, as well as the locations and frequencies of the introductions. Despite monitoring and management efforts, the impact of the introduction and establishment of nonnative species in the park would range from minor to moderate, and would be long-term and adverse.

Ongoing clean sediment beach nourishment activities in reach 1 are performed on an intermittent basis. These activities impact sediment deposition, and have a minor, short-term, beneficial impact on native plant and animal communities from the reduced erosion that results. "Clean" beach nourishment also reduces the likelihood of introduction of invasive and nonnative plant species into the park.

Restoration work in the park, including invasive vegetation management through the early detection and rapid response program and Invasive Plant Management Plan and fencing off highly eroded and environmentally sensitive areas on Mount Baldy, stabilizes select areas of eroded areas in the park with native vegetation. This work would have minor, long-term, beneficial impacts on native plant and animal communities by preserving the natural physiography of the land and restoring lands to their natural states. Similarly, efforts to expand visitor outreach and education opportunities in the park would have minor, long-term, beneficial impacts on native plant and animal communities from the reduction in vegetation trampling and destruction of habitat. Future

realignment of trails would result in minor, long-term, beneficial impacts on terrestrial habitat for native plant and animal communities from reducing social trails (leading to less trampling and the reduced likelihood of introduction of invasive nonnative plant species in the park); though this work would involve negligible to minor, short-term, adverse impacts during construction and re-alignment work due to the temporary disturbance to habitat.

Overall, when the actions described above are added to the existing environment for terrestrial habitat, there would be minor, short- and long-term, adverse and beneficial, cumulative impacts. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under alternative A, there would continue to be minor, short- and long-term, adverse impacts on the terrestrial habitat of native plant and animal communities from the erosion and destabilization that would result from taking no new actions in the park. Cumulatively, there would be minor to moderate, short- and long-term, adverse and beneficial, cumulative impacts on the terrestrial habitat of native plant and animal communities. Adverse impacts would result from continued degradation of habitat that would result from ongoing erosion; beneficial impacts would result from restoration efforts that preserve natural plant and animal habitat in the park. Implementing the actions under alternative A would result in a small increment being added to the overall cumulative impact.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)

The actions associated with alternative B-1 would allow for increased beachfront, thereby providing the potential for a stabilized dune complex, particularly at Mount Baldy. Foredune development under this alternative would be feasible with sediment supply, wind, and an entrapment feature, such as vegetation. In conjunction with the restoration option selected, terrestrial management practices, such as revegetation in areas of beach erosion, would promote the formation of foredunes. These embryotic dunes would protect leeward dunes, pannes, and other ecological features; provide habitat connectivity and sustainability; and contribute sediment (via natural erosion) to the coastal system. These actions would result in minor, short-term, beneficial impacts on the terrestrial habitat for native plant and animal communities. Nourishment of the park shoreline, particularly in areas of accelerated erosion, would result in minor, short-term, beneficial impacts on the terrestrial community.

Under alternative B-1, continued erosion and degradation of the foredune complex would diminish and reduce continued colonization by invasive and nonnative plant species. Revegetation, along with colonization of native plant species would help to prevent nonnative invasive plant species from dominating the area, and have a minor, short-term, beneficial impact on terrestrial habitat. Implementing the actions associated with alternative B-1 would improve the ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals, thereby having a negligible to minor, short-term, beneficial effect.

Actions under alternative B-1 would forestall continued erosion and degradation and provide for a greater amount of sediment added to reach 1 than provided in the past. This beach nourishment, coupled with revegetation in nonsensitive areas, would benefit the terrestrial habitat of native plant and animal communities and have a minor, short-term, beneficial impact; however, a minor, short-term, adverse impact would also result from covering/smothering existing plant species during sediment placement. Plant species endemic to the beach plant community would re-emerge, and colonization and revegetation would provide the basis for a stable system in reach 1. In addition, some nonnative, invasive species would be present in the material from upland

sources, but park management practices, like the early detection and rapid response program and Invasive Plant Management Plan, include early identification and eradication of such species. Implementing actions under alternative B-1 would result in minor, short-term, adverse impacts on the terrestrial habitat for native plant and animal communities.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative B-1, these differences in relation to past, present, and reasonably foreseeable future projects would add a small increment. Cumulative impacts would be minor, short- and long-term and adverse and beneficial. Beneficial impacts would result from the decreased erosion and more stable habitat that would result under this alternative; adverse impacts would result from the temporary smothering of plants and plant and animal habitat during beach nourishment activities and from the temporary displacement of wildlife. Implementing the actions associated with alternative B-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative B-1, there would be minor, short-term, adverse impacts on terrestrial habitat for native plant and animal communities from the introduction of invasive nonnative plant species into the park during sediment placement activities. In addition, minor, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion, would occur under this alternative. Implementing the actions associated with alternative B-1 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants and animals, and result in a negligible to minor, short-term, beneficial effect. The actions under this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)

The actions and impacts associated with alternative B-5 would be similar to those described above for alternative B-1, with a few differences. That is, under alternative B-5, there would be minor, short-term, adverse impacts from the introduction of invasive nonnative plant species in the park during sediment placement activities; negligible to minor, long-term, adverse effects from activities associated with revegetation that would affect sensitive habitats; minor, long-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion; and minor, long-term, beneficial impacts as continued erosion and degradation of the foredune would reduce continued colonization by invasive and nonnative plant species. Implementing the actions associated with alternative B-5 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and have a negligible to minor, long-term, beneficial effect.

Impacts under alternative B-5 would be greater than those under the annual beach nourishment proposed under alternative B-1 because of the longer duration (approximately 18 months every five years) of nourishment activities and the larger footprint of sediment placed on the beach. These actions under alternative B-5 would have moderate, long-term, adverse impacts on terrestrial habitat for native plant and animal communities. The recovery period between placements would be greater than under alternative B-1, which would enhance colonization by native species, and benefit restoration of habitat for threatened and endangered species and species of concern and management of nonnative invasive plant species.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative B-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large incremental addition to the cumulative environment. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the longer duration (approximately 18 months every five years) of sediment placement and from the larger footprint of placement. The actions associated with alternative B-5 would provide a large contribution to overall cumulative impacts.

Conclusion. Under alternative B-5, there would be minor, long-term, adverse impacts on terrestrial habitat for native plant and animal communities from the introduction of invasive nonnative plant species into the park during sediment placement activities; minor, long-term, beneficial impacts from nourishment of the park shoreline; moderate, long-term, adverse impacts from the longer duration (approximately 18 months every five years) of nourishment activities and the larger footprint of sediment placed on the beach; minor, long-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion; and minor, long-term, beneficial impacts as continued erosion and degradation of the foredune would reduce continued colonization by invasive and nonnative plant species. Additionally, the actions associated with alternative B-5 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants.

The actions under this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have moderate, short- and long-term, adverse and beneficial, cumulative effects.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

The actions and impacts associated with alternative C-1 would be similar to those described under alternative B-1. That is, under alternative C-1, there would be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats; and minor, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion. Given the importance of beach nourishment in reducing loss of terrestrial habitat and enhancing the ability to manage nonnative invasive species under this alternative, the impacts would be minor, short-term and beneficial as nourishment material placed would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, and not be likely to introduce weed seeds to the shoreline and beach complex. The actions associated with alternative C-1 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and have a negligible to minor, short-term, beneficial effect.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small increment being added to the cumulative environment. Cumulative impacts would be minor, short- and long-term and adverse and beneficial. Adverse impacts would result from the temporary disturbance to plant and animal terrestrial habitat during placement activities; beneficial impacts would result from the decreased erosion and improved natural habitat for plants and animals. The actions associated with alternative C-1 would provide a small

incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would also be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats. Additionally, minor, short-term, beneficial impacts would result from nourishment of the park shoreline, particularly in areas of accelerated erosion. The actions associated with alternative C-1 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and have a negligible to minor, short-term, beneficial effect. Under this alternative, material would be dredged from an updrift location, and have no or limited viable nonnative invasive plant species seedbank, resulting in a negligible to minor, short-term, beneficial effect on terrestrial habitat. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)

The actions and impacts associated with alternative C-5 would be similar to those described under alternative C-1 with a few differences. Impacts under alternative C-5 would be greater than those under the annual nourishment proposed under alternative C-1 because of the longer duration (approximately 10 months every five years) of nourishment activities and the larger footprint of sediment placed on the beach, resulting in moderate, long-term, adverse effects from the smothering of plants and plant and animal terrestrial habitat during placement activities. The recovery period between placements under alternative C-5 would be longer than under alternative C-1, which would enhance colonization by native species, and benefit restoration of habitat for threatened and endangered species and species of concern and manage nonnative invasive plant species. These actions under alternative C-5 would have moderate, short-term, beneficial impacts on terrestrial habitat for native plant and animal communities.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial. Adverse impacts would result from the disturbance to plant and animal terrestrial habitat during placement activities; beneficial impacts would result from the decreased erosion and improved natural habitat for plants and animals following placement activities. The actions associated with alternative C-5 would provide a large contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would be moderate, short-term, beneficial impacts from nourishment of the park shoreline; and moderate, long-term, adverse impacts from the longer duration (approximately 10 months every five years) of nourishment activities and the larger footprint of sediment placed on the beach. The actions associated with alternative C-5 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and introduce no or limited viable nonnative invasive plant species seedbank since material would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, having negligible to minor, long-term beneficial effects on terrestrial habitat for plants and animals. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term and adverse and beneficial, cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

The actions and impacts associated with alternative D would be similar to those described under alternative C-1. That is, there would be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats, such as those utilized by the piping plover (*Charadrius melodus*). And, there would be minor, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion. The continuation of sediment placement in reach 1 would have limited potential to introduce invasive and nonnative plant species under alternative D because of the clean sediment source for the beach nourishment material. Given the importance of beach nourishment in reducing loss of terrestrial habitat and enhancing the ability to manage nonnative invasive plant species, the impacts under alternative D would be minor, short-term and beneficial because the beach nourishment material would be transported to reach 1 via a permanent bypass system from updrift of the Michigan City Harbor and not be likely to introduce weed seeds to the shoreline and beach complex. The actions associated with alternative D would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and have a negligible to minor, short-term, beneficial effect.

The actions associated with alternative D would involve increasing the amount of sediment placed in the project area through a permanent bypass system, thereby decreasing degradation of the beach and consequently the foredune plant communities. These actions would have minor, short-term, adverse impacts, as some beach vegetation would be smothered during placement. There would also be minor, short-term, beneficial impacts from the decreased erosion and improved natural ecological setting for native plants and animals to thrive on.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small change. Cumulative impacts would be minor, short- and long-term and adverse and beneficial. Adverse impacts would result from the temporary disturbance to plant and animal terrestrial habitat during placement activities; beneficial impacts would result from the decreased erosion and improved natural habitat for plants and animals. The actions associated with alternative D would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative D, there would be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats, and there would be minor, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion. The actions associated with alternative D would involve increasing the amount of sediment placed in the project area through a permanent bypass system, thereby decreasing degradation of the beach and consequently the foredune plant communities. As some beach vegetation would be smothered during placement, actions under alternative D would have minor, short-term, adverse impacts, but also minor, short-term, beneficial impacts from the decreased erosion and improved natural ecological setting for native plants and animals. The actions associated with alternative D would improve the ability of the beach to withstand storm events and preserve terrestrial habitat. The actions of this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative

Like the other action alternatives, the actions associated with alternative E would allow for increased beachfront, thereby providing the potential for dune stabilization, particularly at Mount Baldy. Foredune development would be feasible under this alternative, too, with sediment supply, wind, and an entrapment feature, such as vegetation. In conjunction with the restoration alternative selected, terrestrial management practices, such as revegetation in areas of erosion, would promote the formation of foredunes. Foredune formation would provide habitat connectivity and sustainability and contribute sediment (via natural erosion) to the coastal system. These actions would have minor, long-term, beneficial impacts on terrestrial habitat for native plant and animal communities. Restoration of the park shoreline, particularly in areas of accelerated erosion, through the use of the submerged cobble berm proposed under alternative E, would result in minor, long-term, beneficial impacts on the terrestrial community. The actions associated with alternative E would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and have a minor, long-term, beneficial effect.

Construction of a submerged cobble berm in reach 1 under alternative E would result in longer retention of sediment along the shoreline, thereby decreasing erosion of the beach and the foredune plant communities. While placement of sediment may cover existing vegetation and have minor, short-term, adverse effects, colonization and emergence of covered plants would occur, and have minor, short-term, beneficial impacts. In addition, terrestrial management, including revegetation and management of nonnative invasive plant species, would benefit the native plant community in areas of degradation. Management efforts would not be likely to introduce weed seeds to the shoreline and beach complex because under alternative e nourishment material placed would be obtained from a dredged source, located east, updrift of the Michigan City Harbor structure.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative E. Compared to the cumulative impacts expected under the no-action alternative, under alternative E, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small change. Cumulative impacts would be minor, short- and long-term and adverse and beneficial. Adverse impacts would result from the temporary disturbance to plant and animal terrestrial habitat during placement activities; however, these impacts would be reduced from current impact levels due to the decreased volume of dredged beach nourishment that would be required annually with the addition of a submerged cobble berm that would gradually dissipate. Beneficial impacts would result from the decreased erosion and improved natural habitat for plants and animals, and the reduction in annual beach nourishment volumes. The actions associated with alternative E would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative E, there would be minor, long-term, beneficial impacts on terrestrial habitat for native plant and animal communities from dune stabilization and foredune development; minor, long-term, adverse effects on sensitive habitats from interfering with an already stable area in reach 2; and minor to moderate, long-term, beneficial impacts from restoration of the park shoreline, particularly in areas of accelerated erosion. Impacts would be less than those from the previously described annual beach nourishment activities under alternatives B-1 and C-1. Impacts would be minor to moderate, long-term and beneficial from the reduced consumption of material for nourishment activities. The actions associated with alternative E would improve the ability of

the beach to withstand storm events and preserve terrestrial habitat for plants and animals. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term, adverse and beneficial, cumulative effects.

SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Alternative A (No-action Alternative)

Under the no-action alternative for reaches 3 and 4, there would be no new impacts on the terrestrial habitat of native plant and animal communities in the park, and the actions associated with this alternative would neither invite nor deter invasive species from inhabiting the shoreline and beach complex in reaches 3 and 4. Under alternative A, the current trend of destabilization of the foredunes would continue, especially at Portage Lakefront and Riverwalk. Such destabilization would lead to the localized loss of the natural ecosystems associated with the beach and the foredunes, including plant species endemic to the dunes, as well as insects, reptiles, birds, and mammals dependent upon this habitat. Implementation of the no-action alternative would have minor, short- and long-term, adverse impacts on the terrestrial habitat for native plant and animal communities.

Continued erosion in the vicinity of Portage Lakefront and Riverwalk would be likely under the no-action alternative despite the introduction of dredged material from ongoing beach nourishment activities and habitat loss would continue from the erosion. The possibility of establishing a natural ecosystem is unlikely under the no-action alternative. Taking no new actions in the park would lead to minor, short- and long-term, adverse impacts on the terrestrial habitat for native plant and animal communities. Under alternative A, the beach would continue to erode and would not be able to withstand storm events.

Cumulative Impacts. The cumulative impacts under alternative A in reaches 3 and 4 would be similar to those described above under the no-action alternative for reaches 1 and 2. That is, overall, when the actions described above are combined with the existing terrestrial habitat for native plant and animal communities, there would be minor to moderate, short- and long-term, adverse and beneficial, cumulative impacts. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under alternative A, there would be no new actions taken in the park, including any actions to invite or deter invasive and nonnative plants. If no new actions are taken in the park, there would continue to be minor, short- and long-term, adverse impacts on the terrestrial habitat of native plant and animal communities from the ongoing erosion and destabilization. Taking no new actions in the park would not improve the ability of the beach to withstand storm events. Cumulatively, there would be minor to moderate, short- and long-term, adverse and beneficial, cumulative impacts on the terrestrial habitat of native plant and animal communities. The actions under alternative A would result in a small increment being added to the overall cumulative impact.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

The actions and impacts associated with alternative C-1 for reaches 3 and 4 would be similar to those described above under alternative C-1 for reaches 1 and 2 with a few differences. Under alternative C-1 in reaches 3 and 4, beach erosion in the vicinity of Portage Lakefront and Riverwalk would diminish as a result of dredged material being added to the beach near Ogden Dunes. Under alternative C-1, there would be negligible to minor, short-term, adverse effects from

activities associated with revegetation that would interfere with stable reaches along the shoreline and affect sensitive habitats. In addition, minor, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion, would result under this alternative. The actions associated with alternative C-1 would have negligible to minor, short-term, adverse impacts as some beach vegetation would be smothered during placement activities; however, the potential for site restoration would be enhanced since the amount of beach nourishment would counteract erosion, and have a minor, short-term, beneficial impact. Given the importance of beach nourishment in reducing loss of terrestrial habitat and enhancing the ability to manage nonnative invasive species, impacts under alternative C-1 would be negligible to minor, short-term and beneficial since material dredged from an updrift location in Lake Michigan would have no or a limited viable nonnative invasive plant species seedbank. The actions associated with alternative C-1 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and have a negligible to minor, short-term, beneficial effect.

Additionally, rough-winged swallows (*Riparia riparia*) nest in the foredune "cliff" area created as a result of shoreline erosion. As nourishment material placed on the beach under alternative C-1 would stabilize the shoreline and combat the high rates of erosion, these eroded cliff areas would be reduced, potentially removing the swallows of a suitable nesting habitat, particularly during the placement of the nourishment material. If the eroded cliff was reduced through beach nourishment activities associated with alternative C-1, the terrestrial habitat for the bank swallow would be reduced. There are a few suitable sites for this habitat along Burns Waterway, which would provide an alternative site for the birds, unless the COE completes a restoration project along the waterway that would involve eliminating the steep, open banks. The ephemeral nature of the species' natural nesting venues of muddy banks, dunes, and lakeshores makes this species well-adapted to re-finding appropriate habitat year-after-year (FWS 2007b). Beach nourishment activities under alternative C-1 would reduce erosion and the subsequent maintenance of eroded cliff areas for the birds resulting in minor, short-term, adverse impacts to the bank swallow as they would lose immediate habitat. However, the birds would migrate to other suitable habitat in the near vicinity. Work would be conducted outside critical periods (such as nesting) for these specific species when possible.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small change. Cumulative impacts would be minor, short- and long-term and adverse and beneficial. Adverse impacts would result from the temporary disturbance to plant and animal terrestrial habitat during placement activities; beneficial impacts would result from the decreased erosion and improved natural habitat for plants and animals. The actions associated with alternative C-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats, in addition to minor, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion. The actions associated with alternative C-1 would have negligible to minor, short-term, adverse impacts as some beach vegetation would be smothered during placement; however, the potential for site restoration would be enhanced since the amount of beach nourishment would counteract erosion, and have a minor, short-term, beneficial impact.

Impacts under alternative C-1 would be negligible to minor, short-term and beneficial, since material dredged from an updrift location in Lake Michigan would have no or limited viable nonnative invasive plant species seedbank. The actions associated with alternative C-1 would improve the ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals. Beach nourishment activities under alternative C-1 would reduce erosion and the subsequent maintenance of eroded cliff areas for the bank swallows resulting in minor, short-term, adverse impacts to these birds as they would lose immediate habitat. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative

The actions and impacts associated with alternative C-5 for reaches 3 and 4 would be similar to those described above under alternative C-1, with a few differences. Impacts would be greater under alternative C-5 than under the annual beach nourishment proposed under alternative C-1 because of the longer duration (approximately six months every five years) of nourishment activities and the larger footprint of sediment placed on the beach. Under alternative C-5, there would be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats; moderate, short-term, beneficial impacts from nourishment of the park shoreline; and moderate, long-term, adverse impacts from the longer duration (approximately six months every five years) of nourishment activities and the larger footprint of sediment placed on the beach. The actions associated with alternative C-5 would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants, and nourishment material dredged from an updrift location in Lake Michigan, such as near the NIPSCO/Bailly intake, would have no or limited viable nonnative invasive plants species seedbank, having a negligible to minor, long-term, beneficial effect.

A minor, long-term, adverse impact would occur on bank swallows that nest along the eroded cliffs in reach 4 under alternative C-5, as beach nourishment would reduce erosion and cliff-forming processes, reducing the terrestrial habitat for the bank swallow. As indicated under alternative C-1 for reaches 3 and 4, the birds would migrate to other suitable habitat in the near vicinity. Work would be conducted outside critical periods (such as nesting) for these specific species when possible.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small change. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial. Adverse impacts would result from the disturbance to plant and animal terrestrial habitat during placement activities; beneficial impacts would result from the decreased erosion and improved natural habitat for plants and animals and the improved ability of the beach to withstand storm events. The actions associated with alternative C-5 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would also be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats, in addition to moderate, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion. The actions associated with alternative C-5 would also result in moderate, long-term, adverse effects on terrestrial habitat from the

longer duration (approximately six month every five years) of placement activities and the larger placement footprint. The actions associated with alternative C-5 would improve the ability of the beach to withstand storm events and preserve terrestrial habitat for plants and animals, and would introduce no or limited viable nonnative invasive plant species seedbank since material would be dredged from an updrift location, having negligible to minor, long-term beneficial impacts on terrestrial habitat. A minor, long-term, adverse impact would occur on bank swallows that nest along the eroded cliffs in reach 4 under alternative C-5, as beach nourishment would reduce erosion and cliff-forming processes, reducing the terrestrial habitat for the bank swallow. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

The actions and impacts associated with alternative D for reaches 3 and 4 would be similar to those above under alternative D for reaches 1 and 2, with a few differences. That is, negligible to minor, short-term, adverse impacts from revegetation that would affect sensitive habitats; and minor, short-term, beneficial impacts from nourishment of the park shoreline. The actions associated with alternative D would involve increasing the amount of sediment placed in the project area through a permanent bypass system, thereby decreasing degradation of the beach and consequently the foredune plant communities, and have minor, short-term, adverse impacts as some beach vegetation would be smothered during placement; and also minor, short-term, beneficial impacts from the decreased erosion and an improved natural terrestrial habitat for native plants to thrive.

Under alternative D, beach erosion in the vicinity of Ogden Dunes would diminish as a result of additional material being added to the beach via a permanent bypass system. The addition of beach material would lead to foredune development and habitat loss would diminish. The establishment of a natural ecosystem would be likely through site restoration. Under alternative D, there would be negligible to minor, short-term, adverse impacts as some beach vegetation could be smothered during placement; however, the potential for site restoration would be enhanced, since the amount of beach nourishment would counteract erosion. The actions associated with alternative D would improve the ability of the beach to withstand storm events, preserve terrestrial habitat for plants and animals, and introduce no or limited viable nonnative invasive plants species seedbank since material would be transported to reach 3 via a permanent bypass system from updrift of the NIPSCO/Bailly complex to Portage Lakefront and Riverwalk, and have a negligible to minor, short-term, beneficial effect.

A minor, short-term, adverse impact would occur on bank swallows that nest along the eroded cliffs in reach 4 under alternative D, as beach nourishment would reduce erosion and cliff-forming processes, reducing the terrestrial habitat for the bank swallow. As indicated under alternative C-1 for reaches 3 and 4, the birds would migrate to other suitable habitat in the near vicinity. Work would be conducted outside critical periods (such as nesting) for these specific species when possible.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small change. Cumulative impacts would be minor, short- and long-term and adverse and

beneficial. Adverse impacts would result from the temporary disturbance to plant and animal terrestrial habitat during placement activities; beneficial impacts would result from the decreased erosion and improved natural habitat for plants and animals, and improved ability of the beach to withstand storm events. Implementing the actions associated with alternative D would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative D, there would also be negligible to minor, short-term, adverse effects from revegetation that would affect sensitive habitats; and there would be minor, short-term, beneficial impacts from nourishment of the park shoreline, particularly in areas of accelerated erosion. The actions associated with alternative D would involve increasing the amount of sediment placed in the project area through a permanent bypass system, thereby decreasing degradation of the beach and consequently the foredune plant communities. The actions associated with alternative D would result in minor, short-term, adverse impacts as some beach vegetation would be smothered during placement, as well as minor, short-term, beneficial impacts from the decreased erosion and improved terrestrial habitat for native plants and animals to thrive on. The actions associated with alternative D would improve the ability of the beach to withstand storm events and preserve terrestrial habitat for plants, and would introduce no or limited viable nonnative invasive plant species seedbank since material would be transported to reach 3 via a permanent bypass system from updrift of the NIPSCO/Bailly complex. A minor, long-term, adverse impact would occur on bank swallows that nest along the eroded cliffs in reach 4 under alternative D, as beach nourishment would reduce erosion and cliff-forming processes, reducing the terrestrial habitat for the bank swallow. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current Management Actions

As explained in "The Alternatives" chapter, there are various current management actions of Indiana Dunes National Lakeshore that impact terrestrial habitat for plant and animal species in reaches 1 through 4.

Designation of an approved route from the parking lot to and from Mount Baldy in reach 1 has reduced the anthropogenic influences in that reach, including the trampling of native vegetation and the spread of invasive nonnative plant species, having a negligible to minor, long-term, beneficial impact on the habitat for native plant and animal communities.

Ongoing beach nourishment activities in reaches 1 and 3 have a minor, long-term, adverse impact from the smothering of native vegetation that occurs during sediment placement activities (and the subsequent period it typically takes native species to colonize and re-emerge as a stable population); however, these same activities result in minor, long-term, beneficial impacts from reduced erosion and improved ability of the shoreline to withstand storm events.

Restoration efforts (including installing fencing to protect environmentally sensitive areas and revegetating eroded areas with native vegetation) in the park have minor, long-term, beneficial impacts on terrestrial habitat for native plant communities by preserving and restoring the natural habitat and ecological processes that are critical to this vegetation's survival and reproduction in the park, and by improving the ability of the terrestrial habitat to withstand storm events. Similarly, visitor outreach and education efforts have minor, long-term, beneficial impacts on terrestrial habitat by increasing the knowledge base of visitors in the park and limiting the anthropogenic influences introduced and witnessed in the park.

Invasive vegetation management is performed in all the reaches of the park and includes an early detection and rapid response program and Invasive Plant Management Plan. This work manages the spread of invasive nonnative plants in the park and encourages early detection and eradication of such species, preserving the native habitat. These actions result in minor, long-term, beneficial impacts on the terrestrial habitat of native plant and animal communities.

Proposed Management Actions

Various proposed management actions at the park would impact terrestrial habitat for native plant and animal species in reaches 1 through 4.

The park would continue with the current management actions discussed above, having a minor, long-term, beneficial impact on terrestrial habitat for native plant and animal species by preserving and restoring critical habitat of native plant communities and preserving the ability of the habitat to withstand storm events. By continuing to manage nonnative invasive plant species, the National Park Service would provide a negligible to minor, long-term, beneficial effect on natural processes, including terrestrial habitat for plant communities in the park.

The proposed realigning of trails in the beach reaches would have minor, long-term, beneficial impacts on the terrestrial habitat for native plant and animal communities by limiting the anthropogenic influences witnessed in the park and by reducing the number of social trails (thereby reducing the trampling of native plant species).

Additionally, the park proposes to restore the foredune and dune complex in reach 4 by stabilizing eroded dunes with native vegetation and fencing off highly eroded and environmentally sensitive areas on the foredune to allow for ecological recovery of natural communities. Such work would have a minor, long-term, beneficial impact on the terrestrial habitat for native plant and animal communities by preserving and restoring the natural environment in which the species thrive and improving the ability of such habitat to better withstand storm events.

Cumulative Impacts. Proposed developments, including that proposed in Phase II of the Marquette Plan (IDNR *et al.* 2005), in and around the park would have a minor, short- and long-term, adverse effect on the terrestrial habitat of native plants as construction areas provide pathways for the introduction of invasive nonnative plant species. In addition, construction work would result in the trampling of native vegetation and destruction of critical habitat for native plant and animal species. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under terrestrial habitat as a result of proposed management actions would be negligible to minor, long-term, and beneficial from the actions proposed to preserve terrestrial plant and animal critical habitat and to protect environmentally sensitive areas to allow for ecological recovery of natural communities.

Conclusion. Impacts on the foredune and dune complex in reaches 1 through 4 under terrestrial habitat as a result of proposed management actions would be negligible to minor, long-term, and beneficial from continuing with current management actions to protect and preserve terrestrial plant and animal critical habitat and to fence off highly eroded and environmentally sensitive areas to allow for ecological recovery of natural communities, and from the proposed realigning of trails in the beach reaches to limit anthropogenic influences and social trails experienced in the park, reducing the trampling of native plant species. Proposed developments in and around the park would have a minor, short-term, adverse effect on the terrestrial habitat of native plants as construction areas provide pathways for the

introduction of invasive nonnative plant species and because construction work would result in the trampling of native vegetation and destruction of critical habitat for native plant and animal species. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under terrestrial habitat as a result of proposed management actions would be negligible to minor, long-term, and beneficial.

THREATENED AND ENDANGERED SPECIES AND SPECIES OF CONCERN

METHODOLOGY

The "Affected Environment" chapter provides a description of the federal endangered, threatened, and candidate species found at Indiana Dunes National Lakeshore, including the Karner blue butterfly (*Lycaeides melissa samuelis*), Indiana bat (*Myotis sodalis*), piping plover, Pitcher's thistle, and eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*). Disturbance to these species and their habitat was evaluated by comparing projected changes resulting from implementing the action alternatives to taking no action (i.e., the no-action alternative). Impacts to piping plover and Pitcher's thistle are discussed under each of the alternative discussions below. Impacts to the Karner blue butterfly, Indiana bats, and eastern massasauga rattlesnake are summarized here.

Populations of the Karner blue butterfly do not occur within reaches 1, 2, and 3. Within Indiana Dunes National Lakeshore, there are populations that occur in reach 4 (at West Beach and in the adjacent Miller Woods), but other populations are located further inland. There would be no effect on the Karner blue butterfly under any of the alternatives for any of the reaches because the Karner blue butterfly does not occur in reaches 1, 2, and 3, and because nourishment activities in reach 3 would not affect the populations located within and adjacent to reach 4.

Indiana bats have been found within the inland Heron Rookery Unit of the park but not within reaches 1, 2, 3, and 4 where suitable habitat is unlikely to be present. There would be no effect on the Indiana bat under any of the alternatives for any of the reaches because suitable habitat for the Indiana bat does not occur in reaches 1, 2, 3, and 4.

Although sightings are rare, individual eastern massasauga rattlesnakes have been observed within suitable habitat inland. There would be no effect on the eastern massasauga rattlesnake under any of the alternatives for any of the reaches because actions implemented within the shoreline and beach complex would not affect these habitats and the eastern massasauga rattlesnake is unlikely to inhabit beach areas where nourishment would occur.

Information about the federal endangered, threatened and candidate species was compiled from site visits, research data that is publicly available, information from park staff, and studies of similar actions and effects. Impacts on the species are assessed qualitatively based on the project team's knowledge and best professional judgment.

Intensity Level Definitions

Intensity thresholds for threatened and endangered species and species of concern are defined as follows:

Negligible: The impact is barely detectable and/or would result in no noticeable or perceptible changes in the protection of threatened and endangered species and species of concern.

Minor: The impact is slight but detectable and/or would result in small but noticeable changes in the protection of threatened and endangered species and species of concern.

Moderate: The impact is readily apparent and would result in easily detectable changes in the protection of threatened and endangered species and species of concern.

Major: The impact is severely adverse or exceptionally beneficial, and/or would result in appreciable changes in the protection of threatened and endangered species and species of concern.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

Alternative A (No-action Alternative)

Under the no-action alternative, no new actions would be taken in the park in regards to threatened and endangered species and species of concern and their habitat. Under this alternative, reaches 1 and 2 would continue to experience erosion, beach loss, and degradation of the foredune and dune complex. Moderate, short-term, adverse impacts would result under alternative A from continued erosion, loss of habitat for piping plover and Pitcher's thistle, and the continued sediment budget deficit that would impact habitat for threatened and endangered species. Restoration of habitat for the Pitcher's thistle, and possibly the piping plover, which do not currently occur in reaches 1 and 2, would be unlikely under the no-action alternative. Therefore, under the no-action alternative these species may be affected, and are likely to be adversely affected, because development of future habitat is not addressed and substantial erosion would be likely to continue.

Cumulative Impacts. Several actions, independent of this plan, would affect the park's threatened and endangered species and species of concern. As described in the "Affected Environment" chapter, the unique environment at Indiana Dunes National Lakeshore provides a mosaic of habitats for terrestrial plants and wildlife in a relatively small area.

Independent of this plan, park staff would continue to monitor and protect threatened and endangered species and species of concern in the park to the greatest extent possible. Education and outreach activities, and other actions such as the realignment of some trails in the park, would have negligible to minor, long-term, beneficial effects on these species due to reduced anthropogenic influences. Habitat critical for the preservation of threatened and endangered species and species of concern would thus be maintained.

Additionally, restoration efforts by the park to preserve the foredune and dune complex (such as fencing off highly eroded areas and revegetating eroded areas with native plants) and to stabilize highly eroded areas would have negligible to minor, long-term, beneficial impacts on threatened and endangered species and species of concern by restoring the natural environment/habitat for such plants and animals.

Current and proposed development in and around the park, like that which occurred under Phase I of the Marquette Plan and that which is proposed under Phase II of that plan, would have minor, long-term, adverse impacts on threatened and endangered species and species of concern from the removal of habitat for these species, and minor, short-term, adverse impacts from the destruction of habitat during construction and the time it takes for species to colonize and re-emerge.

Activities or projects that would introduce new sound sources into the park, like construction and special events, such as the annual Super Boat Grand Prix boat race, would have negligible to minor, short-term, adverse effects on threatened and endangered species and species of concern. These effects, however, would be temporary, lasting only as long as construction or the duration of the special event.

Overall, when the actions described above are added to the existing threatened and endangered species and species of concern scenario, there would be negligible to minor, short- and long-term, adverse and beneficial cumulative impacts. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under the no-action alternative, the Pitcher's thistle and piping plover (which are threatened and endangered species) may be affected, and are likely to be adversely affected, because loss of historical habitat is

not addressed adequately and substantial erosion would likely continue under this alternative. Moderate, short-term, adverse impacts would result under alternative A from continued erosion, loss of habitat for piping plover and Pitcher's thistle, and the continued sediment budget deficit that would impact habitat for threatened and endangered species and species of concern. Cumulatively, there would be negligible to minor, short- and long-term, adverse and beneficial impacts. The actions under alternative A would result in a small increment being added to the overall cumulative impact.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)

Currently, there is no habitat within reach 1 for Pitcher's thistle and piping plover; however, there would be the potential for such habitat to be restored as a result of the beach nourishment proposed under alternative B-1. Therefore, under alternative B-1, there would be moderate to major, short- and long-term, beneficial impacts on these species from habitat restoration, and minor, short-term, adverse impacts as the placement of nourishment material would temporarily disturb the ability of piping plover to nest and Pitcher's thistle to establish. The actions associated with alternative B-1 would affect, but are not likely to adversely affect, the Pitcher's thistle and piping plover (threatened and endangered species).

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative B-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. Beneficial impacts would result from the restoration of habitat for threatened and endangered species and species of concern. The actions associated with alternative B-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative B-1, there would be moderate to major, short-term, beneficial impacts on Pitcher's thistle and piping plover (threatened and endangered species), from the habitat restoration that would result from the expanded beach nourishment activities. The implementation of alternative B-1 would also result in minor, short-term, adverse impacts on threatened and endangered species and species of concern as placement of nourishment material from upland sources would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)

Similar to alternative B-1, there would be the potential for habitat to be restored under alternative B-5 for Pitcher's thistle and piping plover because of the additional beach nourishment that would occur under this alternative. Therefore, under alternative B-5, there would be moderate to major, long-term, beneficial impacts on these species from habitat restoration. Due to the longer placement period (approximately 18 months every five years), there would also be minor to moderate, long-term, adverse impacts from

the placement of nourishment material that would disturb the ability of piping plover to nest and Pitcher's thistle to establish. The actions associated with alternative B-5 would affect, but are not likely to adversely affect, Pitcher's thistle and piping plover (threatened and endangered species).

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative B-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Beneficial impacts would result from the restoration of habitat for threatened and endangered species and species of concern. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. The actions associated with alternative B-5 would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative B-5, there would be moderate to major, long-term, beneficial impacts on Pitcher's thistle and piping plover from the habitat restoration that would result from the expanded beach nourishment activities. The implementation of alternative B-5 would also result in minor to moderate, long-term, adverse impacts on these species as placement of nourishment material from upland sources would disturb the ability of piping plover to nest and for Pitcher's thistle to establish. With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Like the other action alternatives in reaches 1 and 2, under alternative C-1 there would be the potential for Pitcher's thistle and piping plover habitat to be restored because of the additional beach nourishment that would occur via dredging. Therefore, under alternative C-1, there would be moderate to major, short- and long-term, beneficial impacts on these species from habitat restoration, and minor, short-term, adverse impacts from the placement of nourishment material that would temporarily disturb the ability of piping plover to nest and Pitcher's thistle to establish. The actions associated with alternative C-1 would affect, but are not likely to adversely affect, threatened and endangered species and species of concern.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. Beneficial impacts would result from the restoration of habitat for threatened and endangered species and species of concern. The actions associated with alternative C-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would be moderate to major, short-term, beneficial impacts on threatened and endangered species and species of concern from the habitat restoration that would result from the expanded beach nourishment activities. The implementation of alternative C-1 would also result in minor, short-term, adverse impacts on threatened and endangered species and species of concern as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)

Similar to alternative C-1, there would be the potential for habitat to be restored under alternative C-5 for Pitcher's thistle and piping plover because of the additional beach nourishment that would occur via dredging. Therefore, under alternative C-5, there would be moderate to major, long-term, beneficial impacts on these species from habitat restoration. Due to the longer placement period (approximately 10 months every five years), there would also be minor to moderate, short-term, adverse impacts from the placement of nourishment material that would disturb the ability of piping plover to nest and Pitcher's thistle to establish. The actions associated with alternative C-5 would affect, but are not likely to adversely affect, threatened and endangered species and species of concern.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. Beneficial impacts would result from the restoration of habitat for threatened and endangered species and species of concern. The actions associated with alternative C-5 would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would be moderate to major, long-term, beneficial impacts on Pitcher's thistle and piping plover from the habitat restoration that would result from the expanded beach nourishment activities. The implementation of alternative C-5 would also result in minor to moderate, short-term, adverse impacts on these species as placement of nourishment material would disturb the ability of piping plover to nest and for Pitcher's thistle to establish. With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

Like the other action alternatives in reaches 1 and 2, under alternative D, there is the potential for Pitcher's thistle and piping plover habitat to be restored because of the additional beach nourishment that would occur via a permanent bypass system.

Therefore, under alternative D, there would be moderate to major, short-term, beneficial impacts on these species from habitat restoration, and minor, short-term, adverse impacts from the placement of nourishment material that would temporarily disturb the ability of piping plover to nest and Pitcher's thistle to establish. The actions associated with alternative D would affect, but are not likely to adversely affect, Pitcher's thistle and piping plover (threatened and endangered species). Coupled with site restoration, the Pitcher's thistle and piping plover would be likely to benefit as a result of habitat improvements under alternative D.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Beneficial impacts would result from the restoration of habitat for threatened and endangered species and species of concern. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. The actions associated with alternative D would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative D, there would be moderate to major, short-term, beneficial impacts on threatened and endangered species and species of concern from the habitat restoration that would result from the expanded beach nourishment activities via the permanent bypass system that would be constructed. The implementation of alternative D would also result in minor, short-term, adverse impacts on threatened and endangered species and species of concern as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have negligible to minor, short- and long-term, and adverse and beneficial cumulative effects.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative

Under alternative E, there is the potential for Pitcher's thistle and piping plover habitat to be restored because of the additional beach nourishment and greater sediment retention that would occur with the use of a submerged cobble berm in conjunction with a beach nourishment program. Therefore, under alternative E, there would be major, long-term, beneficial impacts on these species from habitat restoration, and minor, short-term, adverse impacts from the placement of the submerged cobble berm that would temporarily disturb the ability of piping plover to nest and Pitcher's thistle to establish. The actions associated with alternative E would affect, but are not likely to adversely affect, threatened and endangered species and species of concern. Coupled with site restoration, the Pitcher's thistle and piping plover would benefit as a result of habitat improvements under alternative E.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative E. Compared to the cumulative impacts expected under the no-action alternative, under alternative E, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Beneficial impacts

would result from the restoration of habitat for threatened and endangered species and species of concern. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. The actions associated with alternative E would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative E, there would be major, long-term, beneficial impacts on Pitcher's thistle and piping plover from the habitat restoration that would result from the placement of the submerged cobble berm. The implementation of alternative E would also result in minor, short-term, adverse impacts on threatened and endangered species and species of concern as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Alternative A (No-action Alternative)

Like the no-action alternative in reaches 1 and 2, no new actions would be taken in the park in regards to threatened and endangered species and species of concern and their habitat under alternative A in reaches 3 and 4. Under this alternative, reaches 3 and 4 would continue to experience erosion, beach loss, and degradation of the foredune and dune complex. Moderate, short-term, adverse impacts would result under alternative A from continued erosion, loss of habitat for piping plover and Pitcher's thistle, and the continued sediment budget deficit that would impact habitat for threatened and endangered species and species of concern. Restoration of habitat for the Pitcher's thistle, and possibly the piping plover, would be unlikely under the no-action alternative. Therefore, under the no-action alternative these species may be affected, and are likely to be adversely affected, because loss of historical habitat would not be addressed adequately and substantial erosion would continue.

Cumulative Impacts. Several actions, independent of this plan, would affect the park's threatened and endangered species and species of concern. Independent of this plan, park staff would continue to monitor and protect threatened and endangered species and species of concern in the park to the greatest extent possible. Education and outreach activities, and other actions, such as the realignment of some trails in the park, would have negligible to minor, long-term, beneficial effects on these species due to reduced anthropogenic influences. Habitat critical for the preservation of threatened and endangered species and species of concern would thus be maintained.

Additionally, restoration efforts by the park to preserve the foredune and dune complex (such as fencing off highly eroded areas and revegetating eroded areas with native plants) and to stabilize highly eroded areas would have negligible to minor, long-term, beneficial impacts on threatened and endangered species and species of concern by restoring the natural environment/habitat for such plants and animals.

Current and proposed development in and around the park, like that which occurred under Phase I of the Marquette Plan and that which is proposed under Phase II of that plan, would have minor, long-term, adverse impacts on threatened and endangered species and species of concern from the removal of habitat for these species, and minor, short-term, adverse impacts from the destruction of habitat during construction and the time it takes for species to colonize and re-emerge.

Activities or projects that would introduce new sound sources into the park, like construction and special events, such as the annual Super Boat Grand Prix boat race, would have negligible to minor, short-term, adverse effects on threatened and endangered species and species of concern. These effects, however, would be temporary, lasting only as long as construction or the duration of the special event.

Overall, when the actions described above are added to the existing threatened and endangered species and species of concern scenario, there would be negligible to minor, short- and long-term, adverse and beneficial cumulative impacts. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under the no-action alternative, the threatened and endangered species, Pitcher's thistle and piping plover, may be affected, and are likely to be adversely affected, because loss of historical habitat is not addressed adequately and substantial erosion would continue under this alternative. Moderate, short-term, adverse impacts would result under alternative A from continued erosion, loss of habitat for piping plover and Pitcher's thistle, and the continued sediment budget deficit that would impact habitat for threatened and endangered species and species of concern. Cumulatively, there would be negligible to minor, short- and long-term, adverse and beneficial impacts. The actions under alternative A would result in a small increment being added to the overall cumulative impact.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Under alternative C-1 in reaches 3 and 4, there would be the potential for Pitcher's thistle and piping plover habitat to be restored because of the additional beach nourishment that would occur via dredging. Under alternative C-1, there would be moderate to major, short-term, beneficial impacts on the threatened and endangered species, Pitcher's thistle and piping plover, from the habitat restoration that would result from the expanded beach nourishment activities. There would also be minor, short-term, adverse impacts as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. Critical habitat for the piping plover is located within the eastern terminus of reach 3, as well as near the water intake operated by NIPSCO. Mining of sediment to be placed on the beach in reach 3 would occur via dredging around the NIPSCO intake, lakeward of the piping plover habitat. The annual dredging operations would not directly disturb the piping plover habitat, though the sound generated from this process would have an indirect effect if conducted during the migration and nesting season (though work would be conducted outside critical periods [such as nesting] for the specific species when possible, and work in areas in or near suitable threatened and endangered bird habitat would occur as late as possible in the summer/fall). With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. No adverse modification of the piping plover critical habitat would occur under this alternative. Overall, the actions associated with alternative C-1 would affect, but are not likely to adversely affect, Pitcher's thistle and piping plover (threatened and endangered species).

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1 in reaches 3 and 4. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Beneficial impacts would result from the restoration of habitat for threatened and

endangered species and species of concern. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. The actions associated with alternative C-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would be moderate to major, short-term, beneficial impacts on threatened and endangered species and species of concern from the habitat restoration that would result from the expanded beach nourishment activities. There would also be minor, short-term, adverse impacts to threatened and endangered species and species of concern as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. Coupled with beach nourishment, dredging would not be an adverse modification to the piping plover habitat under alternative C-1. No adverse modification of the piping plover critical habitat would occur under this alternative. The actions associated with alternative C-1 would affect, but are not likely to adversely affect, Pitcher's thistle and piping plover (threatened and endangered species). This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative

The actions and impacts under alternative C-5 would be similar to those described under alternative C-1 for reaches 3 and 4, except that the nourishment activities would take longer (approximately six months every five years). Under alternative C-5 there would be the potential for Pitcher's thistle and piping plover habitat to be restored because of the additional beach nourishment that would occur via dredging, and there would be moderate to major, long-term, beneficial impacts on threatened and endangered species and species of concern from this. There would also be minor, short-term, adverse impacts as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish.

Under alternative C-5, sediment would be dredged from an updrift location in Lake Michigan, such as near the NIPSCO/Bailly intake, lakeward of the piping plover habitat. The annual dredging operations would not directly disturb the piping plover habitat, though the sound generated from this process would have an indirect effect if conducted during the migration and nesting season (though work would be conducted outside critical periods [such as nesting] for the specific species when possible, and work in areas in or near suitable threatened and endangered bird habitat would occur as late as possible in the summer/fall). With respect to the Pitcher's thistle and piping plover, this alternative may affect, but is not likely to adversely affect these species. No adverse modification of the piping plover critical habitat would occur under this alternative.

The actions associated with alternative C-1 would affect, but are not likely to adversely affect, Pitcher's thistle and piping plover (threatened and endangered species).

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Beneficial impacts would result from the restoration of habitat for threatened and endangered species and

species of concern. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. The actions associated with alternative C-5 would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would be moderate to major, long-term, beneficial impacts on threatened and endangered species and species of concern from the habitat restoration that would result from the expanded beach nourishment activities. There would also be minor, short-term, adverse impacts as placement of nourishment material would temporarily disturb the ability of piping plover to nest and for Pitcher's thistle to establish. Coupled with beach nourishment, dredging would not be an adverse modification to the piping plover habitat under alternative C-5. No adverse modification of the piping plover critical habitat would occur under this alternative, and the actions associated with alternative C-5 would affect, but are not likely to adversely affect, these threatened and endangered species. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

The actions and impacts under alternative D would be similar to those described under alternative C-1 for reaches 3 and 4, except that nourishment would be conducted via a permanent bypass system for sediment transport. Like the other action alternatives proposed for reaches 3 and 4, there is the potential for Pitcher's thistle and piping plover habitat to be restored because of the additional beach nourishment that would occur, resulting in moderate to major, short-term beneficial impacts on these threatened and endangered species from the habitat restoration that would result. The continuation of sediment placement in this reach would be of benefit to the Pitcher's thistle and piping plover. Habitat restoration at an increased level of beach nourishment would occur. The actions associated with alternative D would result in minor, short-term, adverse impacts from placement activities, and may affect, but are not likely to adversely affect these species as placement of the nourishment material may temporarily disturb the ability for piping plover to nest and for Pitcher's thistle to establish. Work would be conducted outside critical periods (such as nesting) for the specific species when possible. In addition, work in areas in or near suitable threatened and endangered bird habitat would occur as late as possible in the summer/fall.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor to moderate, short- and long-term, and adverse and beneficial. Adverse impacts would result from the temporary disturbance to habitat for threatened and endangered species and species of concern during placement activities, affecting the ability of some species to nest and establish. Beneficial impacts would result from the restoration of habitat for threatened and endangered species and species of concern. The actions associated with alternative D would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative D, habitat loss would diminish and the possibility of the establishment of a natural ecosystem would be likely, resulting in moderate to major, short-term, beneficial impacts. The continuation of sediment placement in this reach would be of

benefit to the Pitcher's thistle and piping plover. Habitat restoration at an increased level of beach nourishment would occur. The actions associated with alternative D would result in minor, short-term, adverse impacts during placement activities, and may affect, but are not likely to adversely affect these species. Coupled with beach nourishment, a permanent bypass system would not be an adverse modification to the piping plover habitat. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, and adverse and beneficial cumulative effects.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current Management Actions

The current management actions described in "The Alternatives" chapter for the foredune and dune complex have multiple impacts on threatened and endangered species and species of concern. Ongoing beach nourishment activities in reaches 1 and 3 provide a minor, short-term, beneficial impact on threatened and endangered species and species of concern by preventing erosion, thus protecting critical habitat for these species. Placement activities also result in negligible to minor, short-term, adverse effects from the temporary disruption of habitat to these species during these activities.

Current management efforts to maintain, protect, and restore eroding areas (such as fencing off highly eroded areas and revegetating with native plants) in the park have minor, long-term, beneficial impacts on threatened and endangered species and species of concern from the preservation and restoration of critical habitat for these species. Activities related to these efforts have negligible to minor, short-term, adverse effects that last only as long as construction/maintenance work from the temporary disruption to critical habitat.

Invasive vegetation management in the park has minor, long-term, beneficial impacts on threatened and endangered species and species of concern from the restoration of critical habitat for these species, although there are negligible to minor, short-term, adverse effects during activities related to revegetation and management efforts that result from the temporary disruption of habitat for these species.

Education and outreach activities that help limit anthropogenic influences in the park have negligible to minor, long-term, beneficial impacts on threatened and endangered species and species of concern by preserving their habitat and reducing their exposure to outside influences.

By preserving existing ecological conditions through sustaining natural coastal processes, the National Park Service is providing a negligible to minor, long-term, beneficial effect on the threatened and endangered species and species of concern within the park, particularly piping plover and existing populations of Pitcher's thistle.

Proposed Management Actions

The proposed management actions are described in "The Alternatives" chapter. The park proposes to continue with the current management actions described above, having a negligible to minor, long-term, beneficial impact on threatened and endangered species and species of concern by increasing the potential for these species to find suitable habitat in the park and to inhabit the park.

Cumulative Impacts. Ongoing planned facility upgrades and proposed new developments in the park (such as those proposed under Phase II of the Marquette Plan) would have minor to moderate, short-term, adverse impacts on threatened and endangered species and species of concern from the sound that construction-related activities would bring in to the park that could temporarily displace threatened and

endangered species and species of concern during construction and from the temporary disturbance to habitat during these activities. Special events near the park, like the Super Boat Grand Prix, would have negligible to minor, short-term, adverse impacts on threatened and endangered species and species of concern from the increase in sound in the park during such activities, and from the increase in anthropogenic influences (e.g., native vegetation trampling and increased numbers of social trails) that typically result during and after increased visitorship periods.

Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under threatened and endangered species and species of concern as a result of proposed management actions would be negligible, long-term, and beneficial as a result of increasing the potential for these species to find suitable habitat in the park and to inhabit the park over the long term.

Conclusion. Impacts on the foredune and dune complex in reaches 1 through 4 under threatened and endangered species and species of concern as a result of proposed management actions would be negligible to minor, long-term, and beneficial from actions being taken to increase the potential for these species to find suitable habitat in the park and to inhabit the park. Ongoing planned facility upgrades and proposed new developments in the park would have minor to moderate, short-term, adverse impacts on threatened and endangered species and species of concern from the sound that construction-related activities would bring in to the park that could temporarily displace threatened and endangered species and species of concern during construction and from the temporary disturbance to habitat during these activities. Special events near the park, like the Super Boat Grand Prix, would have negligible to minor, short-term, adverse impacts on threatened and endangered species and species of concern from the increase in sound in the park during such activities, and from the increase in anthropogenic influences that typically result during and after increased visitorship periods. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under threatened and endangered species and species of concern as a result of proposed management actions would be negligible, long-term, and beneficial.

WETLANDS AND PANNES

METHODOLOGY

As explained in the "Affected Environment" chapter, there are two wetland features specific to Indiana Dunes National Lakeshore, the aquatic and panne communities. Impacts on wetlands and pannes were evaluated by comparing projected changes resulting from implementing the action alternatives to taking no action (i.e., the no-action alternative).

Information about the park's wetlands and pannes was compiled from site visits, research data that is publicly available, information from park staff, and studies of similar actions and effects. Impacts on wetlands and pannes were assessed qualitatively based on the project team's knowledge and best professional judgment.

Intensity Level Definitions

Intensity thresholds for wetlands and pannes are defined as follows:

Negligible: The impact is barely detectable and/or would result in no noticeable or perceptible changes to wetlands and pannes in the park.

Minor: The impact is slight but detectable and/or would result in small but noticeable changes to wetlands and pannes in the park.

Moderate: The impact is readily apparent and would result in detectable changes to wetlands and pannes in the park.

Major: The impact is severely adverse or exceptionally beneficial, and/or would result in appreciable changes to wetlands and pannes in the park.

SHORELINE AND BEACH COMPLEX, REACHES 1 THROUGH 4

The entire shoreline at Indiana Dunes National Lakeshore is classified as a wetland. Under the no-action alternatives and action alternatives for all reaches, the shoreline would remain un-vegetated beach wetland communities. Under the current nourishment activities taking place under the no-action alternative, as well as under the actions that would take place under the action alternatives for all reaches, temporary impacts to the beach wetlands would result from the placement of nourishment material directly on the beach. However, there would be a benefit to the wetland habitat as a result of the nourishment activities, including continued maintenance of the sediment required to sustain the un-vegetated beach wetland habitat. Natural ecological processes would function as they did prior to disturbance, to the extent practicable. No wetlands outside of the project area would be adversely impacted, resulting in no-net-loss of wetlands. This meets the NPS "no-net-loss of wetlands" policy as stated in NPS Director's Order 77-1: *Wetland Protection and Procedural Manual #77-1*. Under the action alternatives, the resulting shoreline (post-restoration) would be the same acreage of the same wetland type as currently exists, either maintained in its present position or shifted northward because a comparable shoreline profile would develop. As such, the project would be considered under the Restoration Exception in Section 4.2.1(h) of NPS Director's Order 77-1 and would be an excepted action. A Wetland Statement of Findings would not need to be prepared. There would be no incremental or cumulative effects on wetlands because the project would not affect the overall acreage or type of wetlands either within or outside of the project area.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current Management Actions

As explained in "The Alternatives" chapter, there are various current management actions taking place in the reaches of Indiana Dunes National Lakeshore that impact wetlands and pannes in reaches 1, 3, and 4 (reach 2 has no wetlands or pannes). These include the ongoing beach nourishment activities that take place on an intermittent basis in reaches 1 and 3. Such beach nourishment activities help prevent erosion and protect the existence of wetlands and pannes, having a negligible to minor, short-term, beneficial impact on these resources.

At blowout locations in the park, invasive plant management is performed to help protect Pitcher's thistle populations, having a negligible to minor, long-term, beneficial effect on these populations and the wetlands and pannes in areas that surround them. In addition, invasive nonnative plant species management, which include the early detection and rapid response program and Invasive Plant Management Plan, in other areas of the park (such as West Beach and Miller), help preserve the pannes (the foredune complex at Miller is interrupted by leeward pannes and aquatic plant communities and West Beach has the largest concentration of high quality pannes in the project area). These activities have negligible to minor, long-term, beneficial effects on wetlands and pannes, as do measures that are taken by the park to manage anthropogenic influences in the reaches, such as fencing and visitor outreach and education (West Beach is one of the most popular and highly visited entry points in the park with numerous social trails extending from the parking lots to the beach that traverse through sensitive habitat within the foredune and dune complex). Outreach and education create visitor awareness of the impacts of invasive nonnative plant species and anthropogenic influences in the park.

Current restoration and resource protection projects in the park, such as the early detection and rapid response program and Invasive Plant Management Plan and revegetation with native seeds, have minor, long-term, beneficial impacts on wetlands and pannes from the early detection and eradication of such species.

Proposed Management Actions

As explained in "The Alternatives" chapter, there are multiple proposed management actions for Indiana Dunes National Lakeshore that would impact wetlands and pannes in reaches 1, 3, and 4. If the park proceeds with expanding their education and outreach efforts, there would be negligible to minor, long-term, beneficial impacts on wetlands and pannes from the increased visitor awareness of these sensitive areas. In addition, should the park proceed with realigning some trails in the park, there would be negligible to minor, long-term, beneficial impacts on wetlands and pannes from the reduction in anthropogenic influences in these resource areas. Similarly, future actions by the park to restore the foredune and dune complex by stabilizing eroded dunes with native vegetation and fencing off highly eroded and environmentally sensitive areas on the foredune to allow for ecological recovery of natural communities would have minor, long-term, beneficial impacts on wetlands and pannes by preserving their natural environment.

Cumulative Impacts. Proposed development projects, like those included in Phase II of the Marquette Plan (IDNR *et al*. 2005), would have negligible, short-term, adverse impacts on wetlands and pannes from disruption to these sensitive landforms during construction activities. Development in the park would also have minor, long-term, adverse impacts from the take of some of these lands that would be required to build the proposed developments.

Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under wetlands and pannes as a result of proposed

management actions would be negligible to minor, long-term, and beneficial from the actions proposed to educate visitors on anthropogenic influences on wetlands and pannes and from protection and restoration measures that would be taken for these environmentally sensitive areas.

Conclusion. Impacts on the foredune and dune complex in reaches 1 through 4 under wetlands and pannes as a result of proposed management actions would be negligible to minor, long-term, and beneficial from the park expanding its education and outreach efforts, increasing visitor awareness of these sensitive areas. In addition, realigning some trails in the park would have negligible to minor, long-term, beneficial impacts on wetlands and pannes from the reduction in anthropogenic influences in these resource areas. Actions to restore the foredune and dune complex by stabilizing eroded dunes with native vegetation and fencing off highly eroded and environmentally sensitive areas on the foredune to allow for ecological recovery of natural communities would have minor, long-term, beneficial impacts on wetlands and pannes by preserving their natural environment. Proposed development projects would have negligible, short-term, adverse impacts on wetlands and pannes from disruption to these sensitive landforms during construction activities; such development would also have minor, long-term adverse impacts from the take of some of these lands that would be required to build the proposed developments. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under terrestrial habitat as a result of proposed management actions would be negligible to minor, long-term, and beneficial.

SOUNDSCAPE

METHODOLOGY

As explained in the "Affected Environment" chapter, the soundscape of Indiana Dunes National Lakeshore includes both the human and natural environment. The sound environment of the park changes seasonally. Visitors perceive the soundscape subjectively and typically seek out areas of the park where they can either experience the natural quiet or areas where human-generated sounds dominate, depending on their personal preference. Impacts to the soundscape under each alternative were analyzed to assess how the actions associated with each would help identify a series of management actions that could be implemented by park staff, as needed, to provide a balance between protection of the shoreline ecosystem and appropriate visitor enjoyment of the park. The National Park Service's Director's Order 47: *Preservation and Noise Management* defines noise as "an unwanted or undesired sound, often unpleasant in quality, intensity or repetition. This makes noise a subjective term and pushes society to address which sounds or aspects of sound constitute unwanted interruptions in specific situations. Noise is often a byproduct of desirable activities or machines. In a national park setting, noise is a subset of human-made noise." For purposes of this plan / draft EIS, soundscape and natural sounds apply to the environment; noise is only referred to in discussions of impacts. Information about the soundscape at Indiana Dunes National Lakeshore was compiled from data from park staff and studies of similar actions and effects. Soundscape impacts were assessed quantitatively and qualitatively for this resource, based on the project team's knowledge and best professional judgment.

Intensity Level Definitions

Intensity thresholds of visitor experience are defined as follows:

Negligible: The impact is barely detectable and/or would result in no noticeable or perceptible changes in the soundscape of the park.

Minor: The impact is slight but detectable and/or would result in small but noticeable changes in the soundscape of the park.

Moderate: The impact is readily apparent and would result in easily detectable changes in the soundscape of the park.

Major: The impact is severely adverse or exceptionally beneficial, and/or would result in appreciable changes in the soundscape of the park.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

Alternative A (No-action Alternative)

Under the no-action alternative, there would be no changes to the park's soundscape. The current beach nourishment program at the park includes sediment being placed along the shoreline at Crescent Dune from a permitted upland borrow site. This sediment is deposited on an intermittent basis and is graded along the beach with minimal equipment, having a minor, short-term, adverse impact from the noise that's generated during placement and grading activities. Under the no-action alternative, there would be no new impacts on the soundscape.

Cumulative Impacts. Current human and natural sound from inside and outside the park has affected the natural soundscape of Indiana Dunes National Lakeshore in the past, and would continue to do so in the future. The park experiences sound intrusions from various transportation corridors, including the roads that run through and

around the park; such sound intrusions have negligible, long-term, adverse effects on the soundscape since the park is surrounded by substantial development and industry. The park also experiences sound intrusions from existing industry development; for example, NIPSCO operations produce rhythmic mechanical industrial sounds that have negligible, long-term, adverse impacts on the sound environment at the park from ongoing, routine operations.

Just as the soundscape at the park varies by season and high-use times (i.e., holidays and weekends), the soundscape also varies with events. The Super Boat Grand Prix, a Michigan City sponsored event that has taken place the past three years, adds to the existing soundscape setting under the no-action alternative with minor, short-term, adverse impacts that are temporary, lasting as long as event set up, event run, and event take down. These impacts result from the increased number of boats operating in the lake, the increased number of visitors in the park during the event, and the addition of event sponsors and staff commuting to and from and being in the park to run the event.

The Northern Indiana Commuter Transportation District (the South Shore Railroad), which currently traverses the park, incrementally adds minor, long-term, adverse effects to the natural soundscape in the park from the sounds generated during daily operation of the train.

Should any of the proposed development or construction in or around the park take place (see the "Cumulative Impacts Scenario" section for a listing of the development projects proposed under the Marquette Plan) (IDNR *et al.* 2005), there would be an incremental addition of minor, short-term, adverse effects on the soundscape from the sound that would be generated from the related construction activities, including the operation of construction equipment.

Ongoing restoration, preservation, and invasive vegetation management work in the park incrementally add only negligible to minor, short-term, adverse effects on the existing soundscape, since this work is routine and cyclic, and already part of the existing soundscape at the park.

It is possible in the future that those events outside the boundaries of the park, such as recreational boating, would generate substantial sounds that would be heard in the park. New developments adjacent to the park would also result in sound generation during and after construction in these areas. These actions would incrementally add to the existing soundscape with negligible to minor, short- and long-term, adverse impacts during construction and associated daily living/operational activities.

Overall, if the actions described above were added to the existing soundscape, there would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under alternative A, there would be minor, short-term, adverse impacts from beach nourishment activities related to sound generated from the trucks hauling the sediment and the sediment being graded along the shoreline. No new impacts on the existing soundscape in reaches 1 and 2 would result under this alternative since no new actions would be taken. Cumulatively, there would be negligible to minor, short- and long-term, adverse impacts on the natural soundscape from the sounds associated with special events, construction/development projects, and restoration and preservation work. The actions under alternative A would result in a very small increment being added to the overall cumulative impact.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)

Under alternative B-1, beach nourishment material would be mined and placed on the beach each year at Crescent Dune from a permitted upland source by trucks traveling along an existing access road. As many as five bulldozers would be employed to distribute the sediment along the beach. The beach nourishment activities would occur over approximately four months every year in off-peak months, if possible. The beach construction area would be closed to visitors during this time. These actions associated with alternative B-1 would result in negligible to minor, short-term, adverse impacts on the soundscape in the park.

Ambient daytime noise levels within reach 1 may range from 30 A-weighted decibels (dB[A]) in areas away from human activities to 60 dBA near areas of greater human activity, such as the Michigan City Marina to the east and Lakefront Drive to the west. Under alternative B-1, up to 80 trucks per eight-hour day, five days per week, would deliver sediment to reach 1, and as many as five bulldozers would be actively moving sediment toward the western portion of the reach. Depending on the age and condition of the construction equipment, noise levels from a large diesel truck would range up to near 90 dBA at a distance of 50 feet, while the bulldozer sound level would range up to 95 dBA at a distance of 50 feet (EPA 1971). Sound intensity attenuates with distance as it propagates over a larger area, generally in a spherical spreading pattern, away from a stationary noise source, or "point source" where the sound waves were generated. Generally speaking, noise generated by a point source decreases by approximately 6 dBA over hard surfaces (e.g., reflective surfaces such as parking lots or smooth bodies of water), and 7.5 dBA over soft surfaces (e.g., absorptive surfaces such as soft dirt, grass, or scattered bushes and trees) for each doubling of distance. Visitors would experience near ambient daytime noise levels within the nearby open beach areas because visitors would be excluded from the beach areas where nourishment activities would take place. Visitors would continue to experience the natural sound environment in the park that exists under the no-action alternative. Therefore, truck and equipment operation under alternative B-1 would have a negligible to minor, short-term, adverse impact on the soundscape.

There would be fewer park visitors impacted, although terrestrial fauna would be affected by impacts on the soundscape, because activities under alternative B-1 would take place during the off-season as much as possible. If beach nourishment under alternative B-1 occurred in the fall months, the food gathering and other winter preparation activities of small mammals would be impacted by the sounds and vibrations from the trucks and construction equipment. Additionally, fall migratory birds that find rest, refuge, and forage in the park after their Lake Michigan overflight, would be disturbed and stressed by these activities. Impacts under alternative B-1 would be negligible to minor, short-term and adverse because of these effects on terrestrial fauna.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-1. If those impacts were added to the impacts under alternative B-1, there would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape from the addition of sound in the park to execute the actions associated with this alternative. Impacts under alternative B-1 would occur on week days during the off-peak months; therefore, actions associated with alternative B-1 would add a very small increment to the overall cumulative impact.

Conclusion. Under alternative B-1 there would be negligible to minor, short-term, adverse impacts on the soundscape from beach nourishment activities. These impacts would be primarily due to sound generated

from the trucks hauling the sediment and construction equipment grading the nourishment material along the beach. There would be negligible to minor, short- and long-term, adverse cumulative impacts on the natural soundscape if sounds from the actions associated with alternative B-1 were added to the existing soundscape environment; however, the actions from this alternative would result in a very small increment being added to the overall cumulative impact since work would be performed during off-peak months and during the week.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)

Under alternative B-5, beach nourishment would take place similar as described above under alternative B-1, with a few differences. Under alternative B-5, beach nourishment would take place on a five-year frequency instead of an annual frequency. In addition, the implementation of this alternative would effectively close the reach 1 beach for approximately 18 months every five years. Under alternative B-5, there would be minor to moderate, long-term, adverse effects on the soundscape from these beach nourishment activities and the associated sound generated from hauling and grading activities.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-5. If those impacts were added to the impacts under alternative B-5, there would be negligible to moderate, short- and long-term, adverse cumulative impacts on the soundscape from the addition of sound in the park to execute the actions associated with this alternative. These cumulative impacts would occur during high-use times (e.g., summer), and on weekdays over the course of approximately 18 months every five years. The actions associated with alternative B-5 would therefore add a large effect to the overall cumulative impact.

Conclusion. Under alternative B-5 there would be minor to moderate, long-term, adverse impacts on the soundscape. These impacts would be primarily due to sound generated from trucks hauling sediment and construction equipment grading the nourishment material along the beach. There would be negligible to moderate, short- and long-term, adverse cumulative impacts on the soundscape. The actions associated with alternative B-5 would therefore add a large effect to the overall cumulative impact since work would be performed during the peak and off-peak seasons.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Under alternative C-1, beach nourishment material would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, and placed annually on the beach in reach 1. As many as five bulldozers would be employed to distribute the sediment along the beach. The beach nourishment activities would occur over approximately two months every year during the off-peak season. The beach construction area would be closed to visitors during this time. These actions associated with alternative C-1 would result in negligible to minor, short-term, adverse impacts on the soundscape in the park from the sound they would generate.

Under alternative C-1, dredging equipment would operate 8 to 10 hours per day at a location offshore. Standing at the water's edge, a receptor (i.e., person or animal) would hear the sound of a small- to moderate-sized dredge at a level of approximately 60 dBA on a calm day (Borough of Poole Commissioners 2004). The bulldozers needed to move sediment along the beach would each generate noise levels as high as 95 dBA. Sound intensity attenuates with distance as it propagates over a larger area, generally in a spherical spreading pattern, away from a point source where the sound waves were generated. Generally speaking, noise

generated by a point source decreases by approximately 6 dBA over hard surfaces (e.g., reflective surfaces such as parking lots or smooth bodies of water), and 7.5 dBA over soft surfaces (e.g., absorptive surfaces such as soft dirt, grass, or scattered bushes and trees) for each doubling of distance. Visitors would experience near ambient daytime noise levels within the nearby open beach areas because visitors would be excluded from the beach areas where nourishment activities would take place. Visitors would continue to experience the natural sound environment in the park that exists under the no-action alternative. Therefore, truck and equipment operation under alternative C -1 would have a negligible to minor, short-term, adverse impact on the soundscape.

Under alternative C-1, work would be performed during the park's off-season so there would be fewer park visitors impacted by these activities, although the work would impact terrestrial fauna. If beach nourishment occurred in October and November, the food gathering and other winter preparation activities of small mammals would be impacted by the sound and vibrations from the equipment. Further, fall migratory birds that find rest, refuge, and forage in the park after their Lake Michigan overflight, would be disturbed and stressed by these activities. Under alternative C-1, there would be negligible to minor, short-term, adverse impacts on the natural soundscape of Indiana Dunes National Lakeshore during fall performance of the activities associated with this alternative.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. If those impacts were added to the impacts under alternative C-1, there would be negligible to minor, short- and long-term, adverse cumulative impacts to the soundscape from the addition of sounds in the park to execute the actions associated with this alternative. These cumulative impacts would occur on weekdays under alternative C-1. Therefore, the actions associated with alternative C-1 would add a very small increment to the overall cumulative impact due to the timing of the actions.

Conclusion. The actions associated with alternative C-1 would result in negligible to minor, short-term, adverse impacts. These impacts would be primarily due to sound generated from barges and construction equipment grading the nourishment material along the beach. There would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape if noise impacts under alternative C-1 were added to the existing soundscape; however, the actions from this alternative would result in a very small increment being added to the cumulative impact due to the time of the actions.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)

Under alternative C-5, beach nourishment material would be placed on the beach as described above for alternative C-1, with a few differences. Beach nourishment activities under alternative C-5 would take place every five years rather than annually. In addition, the nourishment material would be placed on the beach on weekdays over approximately 10 months every five years. The actions associated with alternative C-5 would result in minor to moderate, short-term, adverse impacts on the soundscape in the park due to the dredging and spreading of sediment along the shoreline over an approximate 10-month period every five years.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. If those impacts were added to the impacts under alternative C-5, there would be negligible to moderate, short- and long-term, adverse cumulative impacts on the soundscape from the addition of sound in the

park to execute the actions associated with this alternative. These cumulative impacts would occur on weekdays over approximately 10 months every five years. The actions associated with alternative C-5 would therefore add a large increment to the overall cumulative impact.

Conclusion. Under alternative C-5 there would be minor to moderate, short-term, adverse impacts on the soundscape. These impacts would be primarily due to sound generated from construction equipment grading the nourishment material along the beach and from dredging operations. Cumulative impacts would be negligible to moderate, short- and long-term and adverse as sound would occur during peak and off-peak times over approximately 10 months every five years. The actions associated with alternative C-5 would therefore add a large effect to the overall cumulative impact.

Alternative D (Beach Nourishment via Permanent Bypass System)

Under alternative D, a permanent bypass system would be constructed. Construction activities would have a negligible, short-term, adverse impact on the soundscape, lasting only as long as construction. Under this alternative, a permanent bypass system would transport sediment from updrift of the Michigan City Harbor to reach 1. As many as five bulldozers would be employed to distribute the sediment along the beach. The beach construction area would be closed to visitors during this time. These actions associated with alternative D would have negligible, short-term, adverse impacts on the park soundscape.

Under alternative D, the permanent bypass system would operate 8 to 10 hours a day. The exact location of the dredging barges, lift station, and pumps would be determined at a later stage, under a planning effort focused on implementation; however, when standing approximately 300 feet from the equipment, a receptor would be able to hear the sound of a small- to moderate-sized dredge at a level of approximately 60 dBA on a calm day. Bulldozers needed to move sediment along the beach would each generate noise levels at high as 95 dBA. Sound intensity attenuates with distance as it propagates over a larger area, generally in a spherical spreading pattern, away from a point source where the sound waves were generated. Generally speaking, noise generated by a point source decreases by approximately 6 dBA over hard surfaces (e.g., reflective surfaces such as parking lots or smooth bodies of water), and 7.5 dBA over soft surfaces (e.g., absorptive surfaces such as soft dirt, grass, or scattered bushes and trees) for each doubling of distance. Visitors would experience near ambient daytime noise levels within the nearby open beach areas because visitors would be excluded from the beach areas where nourishment activities would take place. Visitors would continue to experience the natural sound environment in the park that exists under the no-action alternative. Therefore, truck and equipment operation under alternative D would have a negligible to minor, short-term, adverse impact on the soundscape during dredging and spreading operations.

Due to the work being performed under alternative D during the park's off-season, there would be fewer park visitors impacted by these activities, although the work would impact terrestrial fauna, as described under alternative C-1 above, impact food gathering and other winter preparation activities. These actions associated with alternative D would result in negligible to minor, short-term, adverse impacts.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. If the impacts under alternative D were added to the existing soundscape, there would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape from the addition of sound in the park to execute the actions associated with

this alternative. Impacts under alternative D would occur on weekdays during the off-peak months; therefore, the actions associated with alternative D would add a very small increment to the overall cumulative impact.

Conclusion. Under alternative D, there would be negligible to minor, short-term, adverse impacts from the sound that would be generated from construction and associated operations of the permanent bypass system. There would be negligible to minor, short- and long-term, adverse cumulative impacts on the natural soundscape if sound generated from the actions associated with alternative D were added to the existing soundscape; however, the actions from this alternative would result in a very small increment being added to the cumulative impact due to the timing of the work.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative

Under alternative E, the placement of a submerged cobble berm would be accomplished by employing a barge and crane. The crane would place the submerged cobble berm offshore approximately 10 feet below the water surface and parallel to the shoreline. The total length and design of the submerged cobble berm would be determined at a later stage, under a planning effort focused on implementation. In conjunction with the submerged cobble berm, a beach nourishment program would be used to restore reach 1 of Indiana Dunes National Lakeshore, although a reduced quantity would be needed as the submerged cobble berm would lessen beach erosion. Sediment placed on the beach would be distributed with as many as five bulldozers. The beach nourishment activities would occur during the off-peak season. The beach construction area would be closed to visitors during this time. These actions associated with alternative E would have negligible, short-term, adverse impacts on the park soundscape.

Under alternative E, the dredge equipment would operate 8 to 10 hours per day at a location offshore. Standing at the water's edge, a receptor would hear the sound of a small- to moderate-sized dredge at a level of approximately 60 dBA on a calm day (Borough of Poole Commissioners 2004). Bulldozers needed to move sediment along the beach would each generate noise levels as high as 95 dBA. Sound intensity attenuates with distance as it propagates over a larger area, generally in a spherical spreading pattern, away from a point source where the sound waves were generated. Generally speaking, noise generated by a point source decreases by approximately 6 dBA over hard surfaces (e.g., reflective surfaces such as parking lots or smooth bodies of water), and 7.5 dBA over soft surfaces (e.g., absorptive surfaces such as soft dirt, grass, or scattered bushes and trees) for each doubling of the distance. Visitors would experience near ambient daytime noise levels within the nearby open beach areas because visitors would be excluded from the beach areas where nourishment activities would take place. They would continue to experience the natural sound environment in the park that exists under the no-action alternative. Therefore, truck and equipment operation under alternative E would have a negligible to minor, short-term, adverse impact on the soundscape during dredging and spreading operations.

There would be fewer park visitors impacted by the actions associated with alternative E since activities would take place during the off-season; therefore, there would be negligible, short-term, adverse impacts to the soundscape from these actions.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative E. If the impacts under alternative E were added to the existing soundscape, negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape would result from the addition of sound in the park

to execute the actions associated with this alternative. Under alternative E, impacts would occur on weekdays during the off-peak months; therefore, the actions associated with alternative E would add a very small increment to the overall cumulative impact.

Conclusion. Under alternative E, there would be negligible, short-term, adverse impacts on the soundscape from the beach nourishment activities. These impacts would be primarily due to sound generated from construction activities as well as barges and construction equipment grading the nourishment material along the beach. There would be negligible to minor, short- and long-term, adverse cumulative impacts on the natural soundscape if sound generated from the actions associated with alternative E were added to the existing soundscape; however, the actions associated with this alternative would result in a very small increment being added to the overall cumulative impact.

SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Alternative A (No-action Alternative)

Under the no-action alternative in reaches 3 and 4, there would be no changes to the park's soundscape. The current beach nourishment program includes the dredging of sediment annually around the NIPSCO/Bailly intake and placing it in the nearshore at Portage Lakefront and Riverwalk. The sediment is then graded along the beach with minimal equipment, having minor, short-term, adverse impacts from the sound that is generated during placement and grading activities. As described in the "Affected Environment" chapter, there are numerous human and natural components of sound in and around the park. Under the no-action alternative, there would be no new impacts on the soundscape from these existing actions.

Cumulative Impacts. The cumulative impacts under alternative A for reaches 3 and 4 would be similar to those described above for the no-action alternative for reaches 1 and 2. Overall, there would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape if the impacts under the no-action alternative were added to the existing soundscape. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under alternative A, there would be minor, short-term, adverse impacts from beach nourishment activities related to sound generated from the sediment being graded along the shoreline. There would be no new impacts on the existing soundscape in reaches 3 and 4 since no new actions would be taken under alternative A. Cumulatively, there would be negligible to minor, short- and long-term, adverse impacts on the natural soundscape. The actions under alternative A would result in a very small increment being added to the overall cumulative impact.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Under alternative C-1, sediment would be dredged from an updrift location in Lake Michigan and placed annually on the beach at Portage Lakefront and Riverwalk. As many as five bulldozers would be employed to distribute the sediment along the beach. The beach nourishment activities would occur over an approximate two-month period every year during the off-peak season. The beach construction area would be closed to visitors during this time. These actions would result in negligible, short-term, adverse impacts on the soundscape in the park from the associated sound generation.

Ambient daytime noise levels within reach 3 may range from 30 dBA in areas away from human activities to higher than 60 dBA near areas of greater human activity such as Burns Waterway Small Boat Harbor to the east and the residential community of Ogden Dunes to the west. Under alternative C-1 in reaches 3 and 4, dredging equipment would operate 8 to

10 hours per day offshore. Standing at the water's edge, a receptor would hear the sound of small- to moderate-sized dredging equipment at a level of approximately 60 dBA on a calm day. Bulldozers needed to move sediment along the beach would each generate noise levels as high as 95 dBA. Sound intensity attenuates with distance as it propagates over a larger area, generally in a spherical spreading pattern, away from a point source where the sound waves were generated. Generally speaking, noise generated by a point source decreases by approximately 6 dBA over hard surfaces (e.g., reflective surfaces such as parking lots or smooth bodies of water), and 7.5 dBA over soft surfaces (e.g., absorptive surfaces such as soft dirt, grass, or scattered bushes and trees) for each doubling of distance. Visitors would experience near ambient daytime noise levels within the nearby open beach areas because visitors would be excluded from the beach areas where nourishment activities would take place. Visitors would continue to experience the natural sound environment in the park that exists under the no-action alternative. Therefore, construction equipment operation under alternative C-1 would have a negligible to minor, short-term, adverse impact on the soundscape during dredging and spreading operations.

Due to the work being performed under alternative C-1 during the park's off-season, there would be fewer park visitors impacted by these activities, although the work would impact terrestrial fauna, as described under alternative C-1 for reaches 1 and 2. Under alternative C-1, there would be negligible to minor, short-term, adverse impacts on the natural soundscape of Indiana Dunes National Lakeshore.

Additionally, due to the location of reaches 3 and 4 in the park, construction-related traffic would have to commute through surrounding neighborhoods to access this area, increasing the daily traffic and related traffic sounds generated for residents and park visitors. Such increases in traffic (and thus, traffic-related sounds) would have a negligible to minor, short-term, adverse impact on the soundscape.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. If the impacts under alternative C-1 were added to the existing soundscape, there would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape from the addition of sound in the park to execute the actions associated with this alternative. Under alternative C-1, impacts would occur on weekdays during the off-peak months; therefore, the actions associated with alternative C-1 would add a very small increment to the overall cumulative impact.

Conclusion. Under alternative C-1, there would be negligible to minor, short-term, adverse impacts. These impacts would be primarily due to sound generated from barges and construction equipment grading the nourishment material along the beach. There would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape if sound generated from the activities associated with alternative C-1 were added to the existing soundscape; however, these actions would result in a very small increment being added to the overall cumulative impact due to the timing of the actions.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative

The beach nourishment activities that would take place under alternative C-5 would be similar to those described above for alternative C-1, with a few differences. Under alternative C-5, beach nourishment activities would take place every five years rather than annually, and these activities would occur over approximately six months every five years. Such actions would have minor to moderate, short-term. adverse impacts on the

soundscape from the sounds that would be generated.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. If the impacts under alternative C-5 were added to the existing soundscape, there would be negligible to moderate, short- and long-term, adverse cumulative impacts on the natural soundscape from the addition of sound in the park to execute the actions associated with this alternative. Impacts under alternative C-5 would occur on weekdays for approximately 10 months every five years. The actions associated with alternative C-5 would therefore add a large effect to the overall cumulative impact.

Conclusion. Under alternative C-5, there would be minor to moderate, short-term, adverse impacts primarily due to sound generated from construction equipment grading the nourishment material along the beach. There would be negligible to moderate, short- and long-term, adverse cumulative impacts on the soundscape as sounds would be generated and occur during high-use times and on weekdays over approximately six months every five years. The actions associated with alternative C-5 would therefore add a large effect to the overall cumulative impact from the sound that would be generated.

Alternative D (Beach Nourishment via Permanent Bypass System)

Impacts under alternative D in reaches 3 and 4 would be similar to those described above for alternative D in reaches 1 and 2. That is, negligible to minor, short-term, adverse impacts from the sound that would be generated from construction of the permanent bypass system.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. If the impacts under alternative D were added to the existing soundscape, there would be negligible to minor, short- and long-term, adverse cumulative impacts on the soundscape from the addition of sound in the park to execute the actions associated with this alternative. Impacts under alternative D would occur on weekdays during the off-peak months; therefore, the actions associated with alternative D would add a very small increment to the overall cumulative impact.

Conclusion. Under alternative D, there would be negligible to minor, short-term, adverse impacts from the sound that would be generated from construction and associated operations of the permanent bypass system. There would be negligible to minor, short- and long-term, adverse cumulative impacts on the natural soundscape if sound generated from the actions associated with alternative D were added to the existing soundscape; however, the actions from this alternative would result in a very small increment being added to the cumulative impact due to the timing of the work.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current Management Actions

The continuation of current management actions described in “The Alternatives” chapter for the foredune and dune complex in reaches 1 through 4 would have no new effect on the *existing* soundscape since no new actions would be introduced into any of the reaches.

Proposed Management Actions

The proposed management actions described in “The Alternatives” chapter for the foredune

and dune complex for reaches 1 through 4 would add negligible, short-term, adverse impacts on the natural soundscape in the park related to the sound generated from the proposed realignment of trails, and development of picnic areas, parking lots, access points, etc. These impacts would be temporary, lasting only as long as construction.

Cumulative Impacts. Sound from development that results from Phase II of the Marquette Plan (IDNR *et al*. 2005) would add negligible, short-term, adverse impacts on the natural soundscape. The Northern Indiana Commuter Transportation District (the South Shore Railroad), which currently traverses the park, incrementally adds minor, long-term, adverse effects to the natural soundscape in the park from the sounds generated during daily operation of the train. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under soundscape as a result of proposed management actions would be negligible to minor, short- and long-term, and adverse from the incremental addition of sounds in the park during construction (short-term) and operation (long-term) of proposed upgrades and developments.

Conclusion. Impacts on the foredune and dune complex in reaches 1 through 4 under the soundscape as a result of proposed management actions would be negligible, short-term, and adverse from the sound that would be generated during the proposed realignment of trails, and development of picnic areas, parking lots, access points, etc. These impacts would be temporary, lasting only as long as construction. Likewise, sound from development that results from Phase II of the Marquette Plan (IDNR *et al.* 2005) would add negligible, short-term, adverse impacts on the natural soundscape. The Northern Indiana Commuter Transportation District (the South Shore Railroad), which currently traverses the park, adds minor, long-term, adverse effects to the natural soundscape in the park from the sounds generated during daily operation of the train. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under terrestrial habitat as a result of proposed management actions would be negligible to minor, short- and long-term, and adverse.

VISITOR EXPERIENCE

METHODOLOGY

Information about visitor use and experience at Indiana Dunes National Lakeshore was compiled from data from park records and studies of similar actions and effects. Impacts were assessed qualitatively for this resource, based on the project team's knowledge and best professional judgment regarding how the proposed actions for each alternative would impact visitor use and experience in the park.

Intensity Level Definitions

Intensity thresholds for visitor experience are defined as follows:

Negligible: The impact is barely detectable and/or would result in no noticeable or perceptible changes in visitors' experience at the park.

Minor: The impact is slight but detectable and/or would result in small but noticeable changes in visitors' experience at the park.

Moderate: The impact is readily apparent and would result in easily detectable changes in visitors' experience at the park.

Major: The impact is severely adverse or exceptionally beneficial, and/or would result in appreciable changes in visitors' experience at the park.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

Alternative A (No-action Alternative)

Under the no-action alternative, visitor opportunities would remain essentially unchanged as the existing management protocol for the shoreline would be continued. Impacts on visitor experience under the no-action alternative would be minor, short-term, and adverse from temporary beach closings during intermittent beach nourishment and grading activities in reach 1. Under the no-action alternative, moderate, long-term, adverse impacts would result from degradation of popular visitor amenities within reaches 1 and 2, as a result of continued shoreline erosion and no new actions being taken.

Cumulative Impacts. Under the no-action alternative, restoration and preventative work in the park would incrementally add minor, short-term, adverse impacts on visitor experience from the resulting trail and beach closings. This work would also have a minor, long-term, beneficial impact on visitor experience from decreased future trail and beach closings and improved scenic views (from restoring natural views), ultimately improving the overall visitor experience at the park. Any action in the park resulting in trail closings and/or pedestrian detours would be readily apparent to visitors, who could express an opinion about them.

Ongoing and planned facility upgrades would incrementally add a negligible to minor, short-term, adverse impact on visitor experience during construction and renovation activities; however, following construction, there would be minor, long-term, beneficial impacts on visitor experience from the availability of improved facilities in the park and from a reduction in future closings of facilities for maintenance and upkeep.

Overall, there would be negligible to minor, short- and long-term, adverse and beneficial, cumulative impacts on visitor experience if the impacts under the no-action alternative were added to the existing visitor environment. Adverse impacts would result from the temporary beach, trail, and facility closings for maintenance work and upgrades, and beneficial impacts would result from the reduction in future closings, improved access

to better facilities, and restoration of scenic views to more natural views. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under alternative A, the impact of taking no new actions in the park would be a minor to moderate, short- and long-term, adverse impact on visitor experience from temporary beach closings and ongoing degradation of popular visitor amenities from continued shoreline erosion. Impacts would continue under alternative A, even though the no-action alternative would have no new impacts on visitor experience. Cumulatively, there would be negligible to minor, short- and long-term, adverse and beneficial impacts on visitor experience. The actions associated with alternative A would result in a small increment being added to the overall cumulative impact.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)

Under alternative B-1, the quantity of beach nourishment material that would be mined and delivered to the lakeshore would be increased compared to alternative A. The sediment would be placed at Crescent Dune on an annual basis over an approximate four-month period each year. To the extent possible, efforts would be made to minimize impacts on visitor experience by conducting beach nourishment activities during off-peak months (i.e., fall and winter months). The actions associated with alternative B-1 would have minor, short-term, adverse impacts on visitor experience from the additional trucks and grading equipment that would appear along the shoreline on an annual basis, disrupting the natural viewsheds of the park for visitors.

Under alternative B-1, the placement area would be temporarily closed to visitors during placement activities for safety purposes, resulting in minor, short-term, adverse impacts on visitor experience from access removal. The actions associated with alternative B-1 would also result in minor, short-term, beneficial impacts on visitor experience as there would be a temporary increase in beach size in the placement area near Mount Baldy, expanding the area available for visitor use and enjoyment.

The actions associated with alternative B-1 would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, resulting in minor, short-term, beneficial impacts on visitor experience from decreased trail and beach closings and pedestrian detours for maintenance and restoration efforts. The shorelines downdrift of Mount Baldy would receive an infusion of sediment from the beach nourishment activities under alternative B-1, impacting not only reach 1, but reach 2 and a portion of reach 3, as well, similarly reducing cyclic maintenance and restoration demands in those areas, having a minor, short-term, beneficial impact on visitor experience.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-1. If the impacts under alternative B-1 were added to the existing environment for visitor experience, there would be minor, short-term, adverse impacts from beach and trail closings for beach nourishment activities, as well as minor, short-term, beneficial, cumulative impacts from decreased future closings and expanded area available for visitor use during the temporary increase in beach size near Mount Baldy. The actions associated with alternative B-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative B-1, there would be minor, short-term and adverse impacts during temporary beach and trail closings for nourishment activities in reach 1. There would also be minor, short-term, beneficial impacts on visitor experience due to the temporary increase in beach size and reduction in future trail closings. The actions associated with this alternative, when

combined with other past, present, and reasonably foreseeable future actions, would have minor, short-term, adverse and beneficial, cumulative effects.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)

Under alternative B-5, the beach nourishment activities described above for alternative B-1 would be similar, with a few differences. The amount of beach nourishment material mined and delivered to the lakeshore from a permitted upland source via trucks would be increased relative to the no-action alternative, and would be placed along the lakeshore for approximately 18 months every five years. Such actions would result in moderate, long-term, adverse impacts on visitor experience from the beach and trail closings for safety reasons. Additionally, under alternative B-5, beach nourishment activities would require additional trucks and grading equipment along the shoreline for approximately 18 months every five years, resulting in additional visual intrusions to the viewshed for visitors, resulting in minor, long-term, adverse impacts.

The actions associated with alternative B-5 would cause a temporary increase in beach size in reach 1, having a minor, short-term, beneficial impact on visitor experience from the expanded area available for visitor use and enjoyment. The actions associated with alternative B-5 would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, and would result in minor, long-term, beneficial impacts on visitor experience from fewer future beach closings for cyclic maintenance and restoration work.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative B-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the beach and trail closings during placement activities (adverse) and from fewer future closings for cyclic maintenance and restoration work (beneficial). The actions associated with alternative B-5 would provide a substantial incremental contribution to overall cumulative impacts.

Conclusion. Under alternative B-5, there would be minor to moderate, long-term, adverse impacts on visitor experience from the visual intrusions being introduced into the park during beach nourishment activities and the beach and trail closings during placement work. In addition, under this alternative there would be minor, short- and long-term, beneficial impacts from the temporary increase in beach size and future reduction in beach closings for nourishment activities due to the decrease in erosion. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, adverse and beneficial impacts.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Under alternative C-1, beach nourishment material would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, and placed on the beach in reach 1 on an annual basis. The amount of sediment would fulfill the calculated sediment budget deficit for reach 1, and this placement would occur during an approximate two-month period each year when impacts on visitor use would be minimized to the extent possible (i.e., during fall or winter months). Overall, minor, short-term, adverse impacts on visitor experience would result under alternative C-1 as

nourishment would require barges and additional grading equipment along the shoreline on an annual basis, impacting the natural viewshed of visitors in the park. Placement activities associated with alternative C-1 would have minor, short-term, adverse impacts on visitor experience from the associated beach and trail closings. A minor, short-term, beneficial impact would also result as there would be a temporary increase in beach size in the beach area near Crescent Dune and Mount Baldy, expanding the area of beach available for visitor use and enjoyment.

The actions associated with alternative C-1 would fulfill the sediment budget deficit calculated for reach 1 and prevent additional erosion. This would result in minor, short-term, beneficial impacts on visitor experience from decreased beach and trail closings that result from cyclic maintenance and restoration work (which would be reduced). The shorelines downdrift of Mount Baldy would receive an infusion of sediment from the beach nourishment activities under alternative C-1, impacting not only reach 1, but reach 2 and a portion of reach 3, as well, similarly reducing cyclic maintenance demands in those areas. This would result in fewer beach closings for work in those areas, again having a minor, short-term, beneficial impact on visitor experience.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor, short- and long-term and adverse and beneficial from the temporary beach and trail closings required during placement activities, the additional visual intrusions that would be introduced into the park, and the decrease in beach and trail closings for annual maintenance and restoration work. The actions associated with alternative C-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would be minor, short-term, adverse impacts that would result from the temporary beach closings and visual intrusions being introduced into the park during placement activities. There would also be minor, short-term, beneficial impacts on visitor experience from the temporary increase in beach size and the decrease in future beach closings that would result from less restoration work having to be performed (from reduced erosion). The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term, adverse and beneficial, cumulative impacts.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)

Under alternative C-5, the beach nourishment activities and impacts described above for alternative C-1 would be similar with a few differences. Under alternative C-5, the beach nourishment material would be dredged every five years rather than annually and dredging activities would take approximately 10 months to complete every five years (longer than the approximate two-month period under alternative C-1 due to the greater volume of sediment being placed and distributed). Under alternative C-5, there would be moderate, short-term, adverse impacts on visitor experience from implementation of this alternative, as beach nourishment would require additional grading equipment along the shoreline for approximately 10 months on a five-year frequency, interrupting the natural viewshed experienced by visitors. Dredging and placement operations would have moderate, short-term, adverse impacts on visitor experience from the associated beach and trail

closings that would take place for safety reasons.

The actions associated with alternative C-5 would have a minor, short-term, beneficial impact on visitor experience as the beach would experience a temporary increase in size near Crescent Dune and Mount Baldy, resulting in a greater area of beach being available for visitor use and enjoyment. The actions associated with alternative C-5 would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, resulting in minor, long-term, beneficial impacts on visitor experience from fewer future beach and trail closings that would take place for cyclic maintenance and restoration work (which would be reduced).

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the temporary beach and trail closings during dredging and placement activities and the visual intrusions that would be added, and from the resultant decrease in future work related to maintenance and restoration of the shoreline (as erosion would decrease). The actions associated with alternative C-5 would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would be moderate, short-term, adverse impacts during dredging and placement activities from temporary beach and trail closings and the visual intrusions such activities and construction equipment would introduce into the visitor's viewshed. There would also be minor, short- and long-term, beneficial impacts on visitor experience from the temporary increase in beach size and the decrease in future beach closings that would result from reduced erosion (and thus reduced maintenance and restoration activities that require beach closings). The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term and adverse and beneficial, cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

Under alternative D, a permanent bypass system would transport sediment to reach 1. The actions associated with alternative D would not result in major changes to visitor experience; however, there would be minor, short-term, adverse impacts from distributing the sediment placed, due to the visual intrusion additional construction equipment would introduce into the park to construct the permanent bypass system, and from the temporary beach and trail closings that would result for safety reasons. Under alternative D, the beach size would temporarily increase and result in minor, short-term, beneficial impacts on visitor experience from the expanded area that would be available for visitor use and enjoyment.

Under alternative D, the permanent small lift stations that would be constructed would be visible near the shoreline, introducing a visual intrusion in the park and interrupting the natural viewshed experienced by visitors. Such actions would have a minor, long-term, adverse impact on visitor experience. The visible lift stations proposed under alternative D would pose a safety hazard to nonconfident swimmers in the park, having a negligible to minor, long-term, adverse effect on visitor experience.

The actions associated with alternative D would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, and would result in minor, short-term, beneficial impacts on visitor experience from reduced beach and trail closings that

result from cyclic maintenance and restoration work (which would be reduced). The shorelines downdrift of Mount Baldy would receive an infusion of sediment from these beach nourishment activities, impacting not only reach 1, but reach 2 and a portion of reach 3, as well, similarly reducing cyclic maintenance and restoration work in those areas, resulting in minor, short-term, beneficial impacts on visitor experience from fewer beach and trail closings.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor, short- and long-term and adverse and beneficial. The actions associated with alternative D would provide a small incremental contribution to overall cumulative impacts in those areas.

Conclusion. Under alternative D, there would be minor, short- and long-term, adverse impacts on visitor experience from temporary beach closings, the visual intrusions construction of the permanent bypass system would introduce in to the park during construction (i.e., construction equipment), and hazards posed to nonconfident swimmers by the lift and pump stations. There would also be minor, short-term, beneficial impacts from the reduction in future beach closings that would result from less cyclic maintenance and restoration work needing to be performed from reduced erosion, as well as the temporary increase in beach size. Implementation of alternative D would also result in minor, long-term, adverse impacts to visitor experience from the visual intrusion the small lift stations would introduce to the park. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term, adverse and beneficial, cumulative effects.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative

Under alternative E, a submerged cobble berm would be used in conjunction with a beach nourishment program to restore reach 1 of Indiana Dunes National Lakeshore. This alternative would stabilize the shoreline through the area, reduce the amount of sediment required to continually replenish the supply of beach sediment, and lessen the interruptions in visitor use of the beach from trucks, grading equipment, and nourishment-related activities. Such actions would have moderate, long-term, beneficial impacts on visitor experience from reduced beach closings for nourishment activities and a reduction in the presence of construction and grading equipment on the beach (improving the visitor's viewshed).

During construction of the submerged cobble berm and beach nourishment activities, there would be minor, short-term, adverse impacts on visitor experience from temporary beach closings and installation activities. Such closings would last only as long as construction and placement of the submerged cobble berm. As described in "The Alternatives" chapter, the submerged cobble berm would be placed in approximately 10 feet of water (at low water datum), with a top elevation of approximately 4 feet below low water datum. The presence of the submerged cobble berm would result in negligible to minor, short-term, adverse impacts as it would pose a safety concern to boaters, particularly deep draft vehicles, before it would disperse across the lakebed. As the submerged cobble berm dissipates, the individual cobble material would be carried towards the beach via wave action to approximately 5 to 6.5 feet below water. The area between this water depth and the shoreline would remain largely free of cobbles. Additionally, after the berm has been

re-shaped, nourishment material placed in subsequent years would cover the berm material, leaving a largely sandy substrate. The submerged cobble berm would have negligible to minor, short-term, adverse impacts on visitor experience, as swimmers would come into contact (though minimal) with the cobbles until they were covered with the additional nourishment material. Mitigation measures would be considered to offset the safety concerns posed to visitors under this alternative.

The actions associated with alternative E would temporarily increase the beach size in reach 1, resulting in minor, short-term, beneficial impacts on visitor experience from the expanded area available for visitor use and enjoyment.

Under alternative E, the submerged cobble berm that would be constructed would result in minor, long-term, adverse impacts on visitor experience from the visual intrusion it would create. The submerged cobble berm would potentially be seen from elevated heights in the park before dispersing along the lake bottom. Minor, short-term, adverse impacts would also result, as the barges used in the dredging operations and the grading equipment for current nourishment activities would interrupt the aesthetics of the shoreline during nourishment on an annual basis. The actions associated with alternative E would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, and result in minor, long-term, beneficial impacts on visitor experience from fewer beach and trail closings as a result of less cyclic maintenance and restoration work needing to be performed in the park.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative E. Compared to the cumulative impacts expected under the no-action alternative, under alternative E, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial. Adverse impacts would result from the temporary beach and trail closings during construction and installation of the submerged cobble berm, from the visual intrusions that the submerged cobble berm would introduce into the park, and from the safety concerns the submerged cobble berm would pose to boaters until it had dissipated. Beneficial impacts would result from the decreased erosion that would result, reducing the frequency of beach and trail closings for cyclic maintenance and restoration work. The actions associated with alternative E would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative E, there would be would minor, short- and long-term, adverse impacts on visitor experience during construction of the submerged cobble berm due to the temporary beach closings and visual intrusion the submerged cobble berm would introduce into the park and the safety concerns it would pose to boaters before dissipation. The submerged cobble berm, until it had dispersed along the lakebed, would result in negligible to minor, long-term, adverse impacts on visitors from the safety concerns it would pose. The park would consider implementing mitigation measures to offset these concerns. Under alternative E, there would also be minor, short- and long-term, beneficial impacts from the reduced maintenance demands and reduced restoration demands that would result in fewer beach and trail closings. The actions of this alternative, when combined with other past, present, and reasonably foreseeable actions would result in minor to moderate, short- and long-term, adverse and beneficial, cumulative effects.

SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Alternative A (No-action Alternative)

Under the no-action alternative for reaches 3 and 4, visitor opportunities would remain essentially unchanged and the existing management protocol for the shoreline would be continued, including the continuation of the dredging of sediment annually around the NIPSCO/Bailly intake. Impacts on visitor experience under the no-action alternative would be similar to those described above for alternative A under reaches 1 and 2. That is, visitor opportunities would remain essentially unchanged as the existing management protocol for the shoreline would be continued. Impacts on visitor experience under the no-action alternative would be minor, short-term, and adverse from temporary beach closings during current clean sediment beach nourishment and grading activities in reach 3. Under the no-action alternative, moderate, long-term, adverse impacts would result from degradation of popular visitor amenities within reaches 3 and 4, as a result of continued shoreline erosion and no new actions being taken.

Cumulative Impacts. The cumulative impacts under alternative A in reaches 3 and 4 would be similar to those described above for the no-action alternative under reaches 1 and 2. That is, the proposed plan would incrementally add negligible to minor, short- and long-term, adverse and beneficial effects on visitor experience. Adverse impacts would result from the temporary beach, trail, and facility closings for maintenance work and upgrades, and beneficial impacts would result from the reduction in future closings, improved access to better facilities, and restoration of scenic views to more natural views. The actions under alternative A would add a small increment to the overall cumulative impact.

Conclusion. Under alternative A, the impact of taking no new actions in the park would be a minor to moderate, short- and long-term, adverse impact on visitor experience from temporary beach closings and ongoing degradation of popular visitor amenities from continued shoreline erosion. Impacts would continue under alternative A, even though the no-action alternative would have no new impacts on visitor experience. Cumulatively, there would be negligible to minor, short- and long-term, adverse and beneficial impacts on visitor experience. The actions associated with alternative A would result in a small increment being added to the overall cumulative impact.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

The actions and impacts under alternative C-1 in reaches 3 and 4 would be similar to those described earlier for alternative C-1 under reaches 1 and 2. That is, minor, short-term and adverse from the visual intrusions the barges and additional grading equipment along the shoreline would introduce into the park on an annual basis for an approximate two-month period each year; minor, short-term and adverse from beach and trail closings and minor, short-term and beneficial as there would be a temporary increase in beach size in reach 3, expanding the area of beach available for visitor use and enjoyment.

The actions associated with alternative C-1 would fulfill the sediment budget deficit for reach 3, preventing additional erosion, resulting in minor, short-term, beneficial impacts on visitor experience from reduced beach and trail closings that would result from cyclic maintenance and restoration work (which would be reduced). reach 4 would receive an infusion of sediment from the beach nourishment activities under alternative C-1, similarly reducing cyclic maintenance and restoration demands in that area. This would result in fewer beach closings for that work, again having a minor, short-term, beneficial impact on visitor experience.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable

future actions described under the no-action alternative would apply under alternative C-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor, short- and long-term and adverse and beneficial. The actions associated with alternative C-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would be minor, short-term, adverse impacts on visitor experience from the visual intrusions introduced into the park and the annual beach and trail closings that would be required during nourishment activities for safety reasons. There would also be minor, short-term, beneficial impacts under this alternative from the temporary increase in beach size in reach 3 (resulting in an expanded area for visitor use and enjoyment), and from reductions in the amount of maintenance and restoration work required from decreased erosion (resulting in fewer beach closings). This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects. The actions of alternative C-1 would add a small increment to the overall cumulative impacts.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative

Under alternative C-5 in reaches 3 and 4, the impacts would be similar to those described above for alternative C-5 under reaches 1 and 2. That is, minor to moderate, short-term, adverse impacts would result from implementation of this alternative, as beach nourishment would require additional grading equipment along the shoreline for approximately six months every five years. This would disrupt the viewshed experienced by visitors. Minor to moderate, short-term, adverse impacts would result under alternative C-5 from beach and trail closings during placement activities for safety reasons. Minor, short-term, beneficial impacts would result from the temporary increase in beach size that would make a greater area of beach available for visitor use and enjoyment.

The actions associated with alternative C-5 would fulfill the sediment budget deficit for reach 3 and prevent additional erosion. This would result in minor, long-term, beneficial impacts on visitor experience due to fewer future beach and trail closings that would take place during cyclic maintenance and restoration work (which would be reduced). Reach 4 would receive an infusion of sediment from the beach nourishment activities under alternative C-5. This would reduce cyclic maintenance and restoration demands in that area, and would result in fewer beach closings for that work, again having a minor, long-term, beneficial impact on visitor experience.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would apply under alternative C-5 for reaches 3 and 4. Under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the temporary beach and trail closings during dredging and placement activities and the visual intrusions that would be added to the park, and from the resultant decrease in future work related to maintenance and restoration of the shoreline (as erosion would decrease. The actions associated with alternative C-5 would provide a substantial incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would be minor to moderate, short-term, adverse impacts on visitor experience from the six-month period of beach closings that would take place every five years and the

visual intrusions that would be introduced into the visitors' viewshed. There would also be minor, short- and long-term, beneficial impacts under this alternative from the temporary increase in beach size, providing visitors with an expanded area to use and enjoy, and from the reduction in future maintenance and restoration work in the park (which would reduce the number of beach and trail closings). The actions of this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term and adverse and beneficial, cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

The actions and impacts that would result under alternative D in reaches 3 and 4 would be similar to those described earlier for alternative D in reaches 1 and 2. That is, minor, short-term, adverse impacts would result on an annual basis from distributing the sediment placed, due to the visual obtrusion additional construction equipment would introduce into the park, and from the temporary beach and trail closings that would result for safety reasons. Under alternative D, the beach size would temporarily increase and result in minor, short-term, beneficial impacts on visitor experience from the expanded area that would be available for visitor use and enjoyment.

Under alternative D, the small lift stations that would be constructed would be visible near the shoreline, introducing a visual intrusion in the park and interrupting the natural viewshed experienced by visitors. Such actions would have a minor, long-term, adverse impact on visitor experience.

The actions associated with alternative D would fulfill the sediment budget deficit for reach 3, preventing additional erosion, and would result in minor, short-term, beneficial impacts on visitor experience from reduced beach and trail closings that result from cyclic maintenance and restoration work (which would be reduced). The shorelines downdrift of reach 3 would receive an infusion of sediment from these beach nourishment activities, impacting reach 4, similarly reducing cyclic maintenance and restoration work in that area, resulting in minor, short-term, beneficial impacts on visitor experience from fewer beach and trail closings.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor, short- and long-term, and adverse and beneficial. The actions associated with alternative D would provide a small incremental contribution to overall cumulative impacts in those areas.

Conclusion. Under alternative D, there would be minor, short- term, adverse impacts on visitor experience from temporary beach closings and visual intrusions being introduced into the park. There would also be minor, short-term, beneficial impacts from the reduction in future beach closings that would result from less cyclic maintenance and restoration work needing to be performed from reduced erosion, as well as the temporary increase in beach size. Implementation of alternative D would also result in minor, long-term, adverse impacts to visitor experience from the visual intrusion the small lift stations would introduce to the park. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term, adverse and beneficial, cumulative effects.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current Management Actions

The current management actions described in "The Alternatives" chapter for the foredune and dune complex have multiple impacts on visitor experience. Ongoing facility upgrades in the park have negligible to minor, short-term, adverse impacts on visitor experience from the temporary loss of access to these facilities and the visual intrusions that are introduced into the park during construction/renovation. Such upgrades also have negligible to minor, long-term, beneficial impacts on visitor experience from access to improved facilities and a reduction in future closings of these facilities for cyclic maintenance.

Current beach nourishment activities in the park have minor, short-term, adverse effects on visitor experience from the resulting beach closings during nourishment activities for safety reasons. Similarly, existing restoration and invasive vegetation management work in the park and work to limit anthropogenic influences has minor, short-term, adverse effects on visitor experience from beach, trail, and dune closings while the park performs this work; however, minor, long-term, beneficial impacts on visitor experience result from an improved viewshed and a reduction in future closings for cyclic maintenance work.

Education and public outreach efforts to visitors by the park have a negligible, long-term, beneficial impact on visitor experience by helping visitors understand the importance of limiting social trails and other anthropogenic influences in the park. This results in fewer trail closings for maintenance and restoration work.

Proposed Management Actions

The proposed management actions described in "The Alternatives" chapter for the foredune and dune complex would have multiple impacts on visitor experience.

The park proposes to expand its education and outreach efforts about nonnative invasive plant species to visitors. Such efforts would result in negligible, long-term, beneficial impacts on visitor experience from the resultant reduction in anthropogenic influences in the park.

To address the apparent anthropogenic influences in the park, the park is considering realigning some trails and is developing a mitigation plan for new/proposed access points. Such actions would result in minor, short-term, adverse impacts on visitor experience during trail closings related to the construction activities associated with such work. These actions would also result in minor, long-term, beneficial impacts on visitor experience from new approved access points, which would result in less trampling of park vegetation by visitors (and thus reduced restoration work, which would equate to fewer trail closings for visitors.

Cumulative Impacts. Proposed construction by the park and surrounding areas and property owners, like the development projects proposed under Phase II of the Marquette Plan (IDNR *et al.* 2005), would have negligible to minor, short- and long-term, adverse impacts due to areas of the park being closed during construction, and from the visual intrusions that construction and construction equipment would introduce into the park, and the visual intrusion that new development would introduce to the natural viewshed of visitors in the park and surrounding areas. The Northern Indiana Commuter Transportation District (the South Shore Railroad), which currently traverses the park, introduces a visual intrusion of track and rail cars into the park, having a minor, long-term, adverse effect on visitor experience.

Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under visitor experience as a result of proposed management actions would be minor, short-

and long-term, and adverse and beneficial. Minor, short-term, and adverse cumulative impacts would result from trail closings during construction and restoration efforts, and from the visual intrusions (e.g., construction equipment) that would be introduced in to the park during such work. Minor, long-term, beneficial impacts would result from reductions in future trail closings from reduced erosion and increased preservation and from increased visitor awareness and knowledge about park resources.

Conclusion. Impacts on the foredune and dune complex in reaches 1 through 4 under visitor experience as a result of proposed management actions would be negligible, long-term, and beneficial from expanded education and outreach efforts about nonnative invasive plant species and the resultant reduction in anthropogenic influences. Realigning trails and developing a mitigation plan for new/proposed access points would result in minor, short-term, adverse impacts on visitor experience during trail closings related to the construction activities associated with such work. Such actions would also result in minor, long-term, beneficial impacts on visitor experience from new improved access points, which would result in less trampling of park vegetation by visitors (thus reduced restoration work, which would equate to fewer future trail closings for visitors). Construction in the park would have negligible to minor, short- and long-term, adverse impacts due to areas of the park being closed temporarily during construction, and from the visual intrusions that construction and construction equipment would introduce into the park, and the visual intrusion that new development would introduce to the natural viewshed of visitors in the park and surrounding areas. The Northern Indiana Commuter Transportation District (the South Shore Railroad), which currently traverses the park, introduces a visual intrusion of track and rail cars into the park, having a minor, long-term, adverse effect on visitor experience. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under visitor experience as a result of proposed management actions would be minor, short- and long-term, and adverse and beneficial.

PARK OPERATIONS

METHODOLOGY

"Park operations" refers to the ability of NPS staff to protect and preserve the resources of Indiana Dunes National Lakeshore and to provide opportunities for enjoyable visitor experiences. Park operations also relates to the effectiveness and efficiency with which NPS staff is able to perform such tasks. National Park Service operational data were compiled from various sources, including park staff, and included data on park staffing, maintenance, budgets, visitor use, funding, and park resource needs to assess the impacts of each of the alternatives being analyzed in this plan.

Intensity Level Definitions

Intensity thresholds of park operations are defined as follows:

Negligible: The impact is barely detectable and/or would result in no noticeable or perceptible changes in current park operations, staffing, and/or funding requirements.

Minor: The impact is slight but detectable and/or would result in small but noticeable changes in current park operations, staffing, and/or funding requirements.

Moderate: The impact is readily apparent and would result in easily detectable changes in current park operations, staffing, and/or funding requirements.

Major: The impact is severely adverse or exceptionally beneficial, and/or would result in appreciable changes in current park operations, staffing, and/or funding requirements.

SHORELINE AND BEACH COMPLEX, REACHES 1 AND 2

Alternative A (No-action Alternative)

Under the no-action alternative, park operations would continue as described in the "Affected Environment" chapter. The park is considering realigning some trails, as well as developing a mitigation plan for new/proposed access points to limit the anthropogenic influences witnessed in the park. Such efforts would have a minor, short-term, adverse impact on park operations due to the staff hours required for developing, planning, and implementing such plans and construction; however, there would also be minor, long-term, beneficial impacts from improved natural conditions in the park and less vegetation trampling, subsequently resulting in fewer routine maintenance and upkeep demands on park staff.

Assuming current funding trends continue and staffing levels remain similar to present levels, the park would be unable to fully achieve desired conditions in program areas such as resource protection and visitor services. Actions associated with the no-action alternative would have minor, long-term, adverse impacts on park operations, but there would be no new impacts.

Cumulative Impacts. Under the no-action alternative, ongoing and planned facility upgrades would have negligible, short-term, adverse impacts on park operations due to the increased demands placed on park staff and operating budgets during planning and construction; however, these upgrades would result in negligible, long-term, beneficial impacts from the increased operating efficiencies that typically come with such upgrades. Similar impacts would result from proposed new development, like the picnic area near the Porter access point that the park is considering.

Resource protection and restoration projects, like the early detection and rapid response program and Invasive Plant Management Plan, would result in minor, long-term, beneficial impacts from increased resource protection and stability that would decrease demands on park operations for maintenance and restoration efforts. Such projects would also pose a minor, short-term, adverse impact on park operations due to the increased demands placed on park staff during planning, development, and implementation of such programs and plans. Monitoring the long-term effects and successfulness of such programs would pose a minor, long-term, adverse impact on park staff due to ongoing monitoring and documentation of each plan's success, adding to the park staff's existing workloads. Cyclic maintenance needs would decrease through restoring the park's native vegetation mix by decreasing the presence of nonnative species in the park, thus having a minor, long-term, beneficial impact on park operations due to the decreased maintenance workload.

Minor, long-term, adverse impacts would occur from the current beach nourishment program that includes sediment being accepted in reach 1 from upland sources. This places demands on park maintenance staff and operating budgets.

Special events, like the annual Super Boat Grand Prix, have minor, short-term, adverse impacts on park operations due to the event planning and execution that is required of park staff for such events.

Under the no-action alternative, the proposed plan would incrementally add negligible to minor short- and long-term, adverse and beneficial effects on park operations. When combined with other past, present, and reasonably foreseeable future actions, park operations would experience overall minor, short- and long-term, adverse and beneficial impacts.

Conclusion. The impact of taking no new actions in the park and continuing with the existing beach nourishment program that includes sediment being accepted in reach 1 from upland sources would be minor, long-term and adverse. Ongoing impacts would continue, even though the no-action alternative would have no new impacts on park operations. When considered with other past, present, and reasonably foreseeable future actions, the proposed plan would incrementally add to cumulative impacts on park operations, having an overall negligible, minor, short- and long-term, adverse and beneficial impact.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency)

Beach nourishment via upland sources with an annual frequency would require additional staff time to monitor and oversee this action, placing additional demands on park staff and budgets from added responsibilities related to planning, communication, and monitoring over approximately four months each year, resulting in minor, short-term, adverse effects on park operations. The actions associated with alternative B-1 would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, and result in minor, short-term, beneficial impacts on park operations from reduced cyclic maintenance and restoration demands for up to a year. The shorelines downdrift of Mount Baldy would receive an infusion of sediment from these beach nourishment activities, impacting not only reach 1, but reach 2 and a portion of reach 3, as well, similarly reducing cyclic maintenance and restoration demands in those areas, resulting in minor, short-term, beneficial impacts on park operations from reduced maintenance workloads.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative B-1, these differences in

relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor, long-term and beneficial under alternative B-1 due to the long-term reductions in workloads from reduced maintenance requirements. Cumulative impacts would also be minor, short-term, and adverse from short-term increases in staff workloads during the annual four-month period of nourishment activities. The actions associated with alternative B-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative B-1, there would be minor, short-term, adverse impacts on park operations from the increased demands that would be placed on park staff and budgets annually. There would also be minor, short-term, beneficial impacts from the resulting reductions in annual cyclic maintenance and restoration work that the park performs. The actions of this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency)

Beach nourishment activities and impacts under alternative B-5 would be similar to those described above under alternative B-1, with a few differences. Under alternative B-5, beach nourishment would take place once every five years with nourishment activities taking approximately 18 months to complete. Moderate, long-term, adverse impacts would result from the additional demands that would be placed on park staff and budgets from increased responsibilities over an approximate 18-month period related to planning, communication, and monitoring; and minor, long-term, beneficial impacts would also result from reduced cyclic maintenance and restoration as a result of decreased erosion.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative B-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative B-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the increases in park staff workloads to implement the actions associated with alternative B-5 and from the reduced cyclic maintenance demands that would result over the five-year. The actions associated with alternative B-5 would provide a substantial incremental contribution to overall cumulative impacts.

Conclusion. Under alternative B-5, there would be moderate, long-term, adverse impacts from the additional planning, execution, and monitoring tasks that would tax employees and operating budgets for approximately 18 months every five years during beach nourishment activities; however, there would also be minor, long-term, beneficial impacts from reduced cyclic maintenance and restoration demands on park staff and park dollars over each five-year period. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term and adverse and beneficial, cumulative effects.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Under alternative C-1, sediment would be dredged from an updrift location, such as the nearshore area east of the Michigan City Harbor, and placed on the beach in reach 1 over an approximate two-month period every year. These activities would place additional demands on park staff from added responsibilities related to planning,

communication, and monitoring. This would result in minor, short-term, adverse effects on park operations. The actions associated with alternative C-1 would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, and would result in minor, short-term, beneficial impacts on park operations from reduced cyclic maintenance and reduced restoration demands. The shorelines downdrift of Mount Baldy would receive an infusion of sediment from these beach nourishment activities, impacting not only reach 1, but reach 2 and a portion of reach 3, as well, similarly reducing cyclic maintenance and restoration demands in those areas, and having a minor, short-term, beneficial impact on park operations.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor, short- and long-term and adverse and beneficial from the decrease in annual maintenance demands to restore the park shoreline and from the increase in park staff workloads during the approximate two-month nourishment period each year. The actions associated with alternative C-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would be minor, short-term, adverse impacts on park operations from the increased demands that would be placed on staff and budgets each year during the approximate two-month period for beach nourishment activities each year. Under this alternative, there would also be minor, short-term, beneficial impacts park operations from the annual decrease in maintenance and restoration work required by park staff and of park budgets. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency)

Beach nourishment activities and impacts on park operations under alternative C-5 would be similar to those described above under alternative C-1, with a few differences. Under alternative C-5, beach nourishment activities would take place every five years versus annually, and dredging activities would take approximately 10 months to complete every five years. Impacts under this alternative would be moderate, short-term and adverse from the additional demands that would be placed on park staff for planning, communication, and monitoring for an approximate 10-month period every five year; and minor, long-term and beneficial from the reduced cyclic maintenance and reduced restoration demands that would result from decreased erosion.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the decrease in park staff workloads to address shoreline beach erosion every five years, and from the short-term increase in staff workloads and additional demands on park operating budgets for the nourishment that would occur over approximately 10 months every five years. The actions associated with alternative C-5 would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would be moderate, short-term, adverse impacts on park operations from the demands the associated activities would place on park staff and budgets. There would also be minor, long-term, beneficial impacts from the resulting decrease in cyclic maintenance and restoration work performed in the park from the decrease in erosion. The actions of this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term, adverse and beneficial, cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

Under alternative D, sediment would be transported via a permanent bypass system from updrift of the Michigan City Harbor to reach 1. This beach nourishment activity would place additional demands on park staff from added responsibilities related to planning, communication, construction, and monitoring. This would result in minor to moderate, short-term, adverse effects on park operations from the increase in staff workloads and the burden that would be placed on operating budgets. In addition, following construction, the permanent bypass system would require monitoring and routine maintenance, adding to existing park staff workloads, resulting in minor to moderate, long-term, adverse impacts on park operations. The actions associated with alternative D would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, resulting in minor, short-term, beneficial impacts on park operations from reduced cyclic maintenance and reduced restoration demands. The shorelines downdrift of Mount Baldy would receive an infusion of sediment from the beach nourishment activities associated with alternative D, impacting not only reach 1, but reach 2 and a portion of reach 3, as well, similarly reducing cyclic maintenance and restoration demands in those areas.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor, short- and long-term and adverse and beneficial from the reduction in annual maintenance demands of the shoreline related to erosion, and from the short-term increase in workloads and operating budget demands related to the nourishment activities. The actions associated with alternative D would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative D, there would be minor to moderate, short- and long-term, adverse impacts on park operations from the increase in park staff responsibilities and the increased demand placed on the park's operating budget to carry out the actions associated with alternative D beach nourishment, especially the routine monitoring and maintenance of the permanent bypass system for the life of this plan. There would also be minor, short-term, beneficial impacts under this alternative from the decrease in maintenance and restoration work that would result from the decrease in erosion that would occur from the annual beach nourishment activities. The actions of this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative

Under alternative E, the one-time construction of the submerged cobble berm would place additional workload demands on

park staff during planning and construction, resulting in minor, short-term, adverse effects on park operations that would last only as long as construction. Over time, the submerged cobble berm would facilitate stabilization of the shoreline and reduce the quantity of sediment needed for beach nourishment along this reach, resulting in moderate, long-term, beneficial impacts on park operations from reduced operating budgets over the proposed plan's lifespan and beyond (from fewer nourishment activities being performed, improved erosion barriers, and fewer maintenance and restoration demands). The actions associated with alternative E would fulfill the sediment budget deficit calculated for reach 1, preventing additional erosion, resulting in moderate, long-term, beneficial impacts on park operations from reduced cyclic maintenance and restoration demands.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative E. Compared to the cumulative impacts expected under the no-action alternative, under alternative E, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be moderate, short- and long-term and adverse and beneficial from the reduced maintenance demands related to shoreline erosion over the life of the plan and from the temporary increase in park staff workloads during construction and placement of the submerged cobble berm. The actions associated with alternative E would provide a large incremental contribution to overall cumulative impacts, adverse in the short-term during construction, but beneficial over the long-term.

Conclusion. Under alternative E, there would be minor, short-term, adverse impacts on park operations during construction of the submerged cobble berm; and moderate, long-term, beneficial impacts on park operations from the reduced maintenance demands, reduced restoration demands, and lower operating budgets over the life of the plan. The actions associated with this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have moderate, short- and long-term and adverse and beneficial, cumulative effects.

SHORELINE AND BEACH COMPLEX, REACHES 3 AND 4

Alternative A (No-action Alternative)

Under the no-action alternative for reaches 3 and 4, park operations would continue to be characterized and impacted as explained under the no-action alternative above for reaches 1 and 2 and no new actions would be taken. Assuming current funding trends continue and staffing levels remained similar to present levels, the park would continue to be unable to fully achieve desired conditions in program areas such as resource protection, visitor services, and cyclic maintenance. The existing beach nourishment program would continue to impact the industrial warm-water discharge location, extending it east towards the park shoreline, impacting aquatic and terrestrial habitats, requiring increased dredging of the federal channel. Such actions would continue to add to the workloads of park staff and increase the operating budget requirements, resulting in minor, long-term, adverse effects on park operations.

In addition, excessive sedimentation around the intake would inhibit the use of the cold-water intake structure, resulting in potential emergency plant shutdowns, imposing additional workloads on park staff and increasing cyclic maintenance demands, resulting in minor, long-term, adverse effects on park operations. Actions associated with the no-action alternative would have minor, long-term, adverse impacts on park operations, but there would be no *new* impacts.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable

future actions described under the no-action alternative for reaches 1 and 2 would also apply under alternative A in reaches 3 and 4. Under the no-action alternative, the proposed plan would incrementally add a negligible to minor, short- and long-term, beneficial and adverse effect on park operations. When combined with other past, present, and reasonably foreseeable future actions, park operations would experience overall minor, short- and long-term, adverse and beneficial impacts, but there would be no new impacts.

Conclusion. The impacts associated with taking no new actions in the park and continuing with the existing dredging that is performed for beach nourishment in reach 3 would be minor, long-term and adverse from the growing workload demands and maintenance operations that would be required. Ongoing impacts would continue, even though the no-action alternative would have no *new* impacts on park operations. When considered with other past, present, and reasonably foreseeable future actions, the proposed plan would incrementally add to cumulative impacts on park operations, having an overall negligible to minor, short- and long-term, adverse and beneficial impact.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency)

Beach nourishment activities and impacts under alternative C-1 in reaches 3 and 4 would be similar to those described above under alternative C-1 for reaches 1 and 2. That is, moderate, short-term, adverse impacts from the added responsibilities that would be placed on park staff for planning, communication, and monitoring of the beach nourishment activities that would take place each year over an approximate two-month period; and minor, short-term, beneficial impacts from reduced cyclic maintenance and reduced restoration demands. The actions associated with alternative C-1 would fulfill the sediment budget deficit estimated for reach 3, preventing additional erosion, resulting in minor, short-term, beneficial impacts on park operations from reduced cyclic maintenance and restoration demands. The shoreline downdrift of Portage Lakefront and Riverwalk would receive an infusion of sediment from these beach nourishment activities, impacting reach 4, similarly reducing cyclic maintenance and restoration demands in that reach.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-1. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-1, these differences in relation to past, present, and reasonably foreseeable future projects would result in a small difference. Cumulative impacts would be minor, short- and long-term and adverse and beneficial from the short-term demands placed on park staff and park operating budgets during beach nourishment activities, and from the short-term, annual reduction in maintenance/restoration work. The actions associated with alternative C-1 would provide a small incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-1, there would be minor, short-term, adverse impacts on park operations from the additional demands that would be placed on park staff and park operating budgets to plan and carry out the required actions annually over an approximate two-month period. There would also be minor, short-term, beneficial impacts from the savings and decreased workloads that would result from the reduced maintenance and restoration demands that would result with less shoreline erosion. This alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor, short- and long-term and adverse and beneficial, cumulative effects.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency) – Preferred Alternative

Beach nourishment activities and impacts on park operations under alternative C-5 would be similar to those described above under alternative C-1, with a few differences. Impacts under this alternative would be minor to moderate, short-term and adverse from the additional demands that would be placed on park staff for planning, communication, and monitoring; and minor, long-term and beneficial from the reduced cyclic maintenance and reduced restoration demands that would result from decreased shoreline erosion. Under alternative C-5, the dredging of sediment would take place every five years rather than annually, and dredging every five years would take approximately six months to complete, resulting in minor to moderate, short-term, adverse effects on park operations from the additional coordination and planning efforts park staff would need to perform to carry out the actions associated with this alternative.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative C-5. Compared to the cumulative impacts expected under the no-action alternative, under alternative C-5, these differences in relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the short-term demands on park staff and park operating budgets to carry out this work and the benefits that would be realized through decreased erosion and related maintenance/restoration work. The actions associated with alternative C-5 would provide a substantial incremental contribution to overall cumulative impacts.

Conclusion. Under alternative C-5, there would be minor to moderate, short-term, adverse impacts on park operations from the additional demands that would be placed on park staff and park budgets (for approximately six months every five years) to carry out the actions associated with this alternative. There would also be minor, long-term, beneficial impacts from the reductions in maintenance and restoration work as the actions associated with this alternative would decrease erosion in the park. The actions of this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term and adverse and beneficial, cumulative effects.

Alternative D (Beach Nourishment via Permanent Bypass System)

Under alternative D in reaches 3 and 4, the actions and impacts would be similar to those described above under alternative D for reaches 1 and 2. That is, minor, short-term, adverse effects on park operations from the increase in staff workloads and the burden that would be placed on operating budgets related to planning, communication, construction, and monitoring; and minor to moderate, long-term, adverse impacts from the monitoring and routine maintenance demands that would be placed on park staff to maintain the permanent bypass system. The actions associated with alternative D would fulfill the sediment budget deficit estimated for reach 3, preventing additional erosion, resulting in minor, short-term, beneficial impacts on park operations from reduced cyclic maintenance and reduced restoration demands. The shorelines downdrift of reach 3 would receive an infusion of sediment from the beach nourishment activities associated with this alternative, impacting reach 4, reducing cyclic maintenance and restoration demands in that area as well.

Cumulative Impacts. The same scenario of past, present, and reasonably foreseeable future actions described under the no-action alternative would also apply under alternative D. Compared to the cumulative impacts expected under the no-action alternative, under alternative D, these differences in

relation to past, present, and reasonably foreseeable future projects would result in a large difference. Cumulative impacts would be minor to moderate, short- and long-term and adverse and beneficial from the short-term impacts on park staff workloads and operating budgets during the construction of the permanent bypass system and the long-term monitoring and maintenance of the permanent bypass system for the life of this plan. The actions associated with alternative D would provide a large incremental contribution to overall cumulative impacts.

Conclusion. Under alternative D, there would be minor to moderate, short- and long-term, adverse impacts on park operations from the additional staff time and operating dollars the associated beach nourishment actions would require, especially the routine monitoring and maintenance of the permanent bypass system for the life of this plan. There would also be a minor, short-term, beneficial impact from the associated erosion decrease and resultant decrease in required maintenance and restoration work by park staff (reducing operating budget drains). The actions of this alternative, when combined with other past, present, and reasonably foreseeable future actions, would have minor to moderate, short- and long-term and adverse and beneficial, cumulative effects.

FOREDUNE AND DUNE COMPLEX, REACHES 1 THROUGH 4

Current Management Actions

The current management actions described in "The Alternatives" chapter for the foredune and dune complex have multiple impacts on park operations.

Current actions to maintain/preserve/restore areas of the park from invasive vegetation and anthropogenic influences, like fencing off highly eroded areas, revegetating eroded areas with native seeds, and conducting visitor education and outreach efforts, have a negligible, short-term, adverse effect on park operations from the workloads these actions require of staff and from the drain on operating budgets. These actions also have a minor, long-term, beneficial impact on park operations from reduced future work requirements related to preserving the foredune and dune complex and reducing anthropogenic influences in the park.

Existing beach nourishment activities in reaches 1 and 3 have a minor, long-term, adverse effect on park operations from the ongoing commitment of park staff and dollars to these efforts.

Education and outreach activities have negligible, short-term, adverse impacts on park operations due to the resource commitments they require; however, such activities also have a negligible to minor, long-term, beneficial impact from reduced cyclic maintenance and invasive vegetation management work as anthropogenic influences are reduced.

Proposed Management Actions

The proposed management actions described in "The Alternatives" chapter for the foredune and dune complex would have multiple impacts on park operations.

The park proposes to expand its education and outreach efforts about the impacts of invasive nonnative plant species and anthropogenic influences in the park. This would have negligible, short-term, adverse impacts on park operations from the additional park resources this would require; however, there would also be negligible to minor, long-term, beneficial impacts from a better educated visitor population and a resultant decrease in anthropogenic influences in the park.

To address the apparent anthropogenic influences in the park, the park is considering realigning some trails and is developing a mitigation plan for new/proposed access points and trails to Crescent Dune. Such

actions would result in minor, short-term, adverse impacts on park operations due to increased workloads and additional operating budget drains to plan, design, and construct/implement trail realignments. In addition, there would be minor, long-term, beneficial impacts on park operations from decreased demands on park staff for cyclic maintenance and restoration after trails were realigned. Development of a mitigation plan for new/proposed access points in reach 1 would have negligible, short- and long-term, adverse impacts on park operations from increased workloads to develop, implement, and monitor the success of such a plan; however, there would also be minor, long-term, beneficial impacts on park operations from reduced cyclic maintenance demands and reduced restoration requirements in this area over the long-term.

Cumulative Impacts. Proceeding with proposed developments, like a picnic area near the Porter access point or other development projects proposed in Phase II of the Marquette Plan (IDNR *et al.* 2005), would have minor, short-term, adverse impacts on park operations because of the additional work demands that would be placed on park staff to plan, develop, and construct such facilities. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under park operations as a result of proposed management actions would be minor, short- and long-term, and adverse and beneficial from the short-term impacts on park staff workloads and operating budgets during planning, coordinating, and construction efforts related to the proposed management actions, and the long-term benefits of reduced future maintenance and restoration work.

Conclusion. Impacts on the foredune and dune complex in reaches 1 through 4 under park operations as a result of proposed management actions would be negligible, short-term, and adverse from expanding education and outreach efforts about the impacts of invasive nonnative plant species and anthropogenic influences in the park because such activities would require park staff time; however, there would also be negligible to minor, long-term, beneficial impacts from a better educated visitor population and a resultant decrease in anthropogenic influences in the park. Realigning some trails and developing a mitigation plan for new/proposed access points and trails to Crescent Dune would result in minor, short-term, adverse impacts on park operations due to increased workloads and additional operating budget drains to plan, design, and construct/implement trail realignments. In addition, there would be minor, long-term, beneficial impacts on park operations from decreased demands on park staff for maintenance and restoration work after trails were realigned. Development of a mitigation plan for new/proposed access points in reach 1 would have negligible, short- and long-term, adverse impacts on park operations from increased workloads to develop, implement, and monitor the success of such a plan; however, there would also be minor, long-term, beneficial impacts on park operations from reduced cyclic maintenance demands and reduced restoration requirements over the long-term. Proceeding with proposed developments would have minor, short-term, adverse impacts on park operations because of the additional work demands that would be placed on park staff to plan, develop, and construct such facilities. Cumulative impacts on the foredune and dune complex in reaches 1 through 4 under park operations as a result of proposed management actions would be minor, short- and long-term, and adverse and beneficial.

SUMMARY OF IMPACT ANALYSIS

UNAVOIDABLE ADVERSE IMPACTS

The National Park Service is required to consider if the alternative actions of a proposed action would result in adverse impacts that would not be fully mitigated or avoided. A summary of unavoidable adverse impacts is presented below by reach and alternative.

Reaches 1 and 2

Alternative A (No-action Alternative). Under the no-action alternative, erosion of the shoreline would continue to occur in reach 1, threatening aquatic and terrestrial habitats and the sediment budget deficit would also continue, resulting in a deficit of material for foredune and dune formation. Taking no new actions in the park would result in continued erosion and destabilization of terrestrial habitat for plants and animals (thus adversely affecting threatened and endangered species and species of concern, as well) and would not improve the ability of the beach to withstand storm events. Short-term, adverse impacts on the natural soundscape would continue during current beach nourishment activities and during high-use times (e.g., summer weekends and holidays) under the no-action alternative. Visitors would continue to be adversely impacted by ongoing beach nourishment activities under the no-action alternative from the continued temporary beach closings and ongoing degradation of popular visitor amenities from shoreline erosion. Aquatic fauna would continue to be adversely affected under the no-action alternative from temporary displacement due to turbidity and the benthic fauna that would be smothered during placement of sediment; additionally, current nourishment activities would result in a disrupted environment which would continue to allow for the introduction/establishment of invasive and nonnative aquatic species. Under the no-action alternative, park operations would continue to be adversely impacted as a result of the ongoing workload demands and maintenance costs associated with existing beach nourishment activities and shoreline erosion.

Alternative B-1 (Beach Nourishment via Upland Sources, Annual Frequency). Under alternative B-1, adverse impacts on terrestrial habitat for plants and animals and on threatened and endangered species and species of concern would result from the introduction of invasive and nonnative plant species. The natural soundscape of the park would be adversely impacted on a temporary basis from the beach nourishment activities related to this alternative, including the trucks hauling sediment and the construction equipment grading the nourishment material along the beach. Native aquatic fauna would be adversely impacted by the actions associated with alternative B-1 as fish would be temporarily displaced due to turbidity and benthic fauna would be temporarily smothered during placement of sediment. Nourishment activities would result in a disrupted environment which would allow for the introduction and/or establishment of invasive and nonnative aquatic fauna species. Visitor experience would be affected adversely on a short-term basis from temporary beach and trail closings for nourishment activities in reach 1 and the visual intrusions that would be introduced in to the park (e.g., construction and grading equipment). The actions associated with alternative B-1 would have an adverse impact on park operations from the increased demands that would be placed on park staff and park budgets annually.

Alternative B-5 (Beach Nourishment via Upland Sources, Five-Year Frequency). The actions associated with alternative B-5 would be similar to those under alternative B-1 except actions would result in long-term, adverse impacts on aquatic and terrestrial habitat for plants and animals, threatened and

endangered species and species of concern, the natural soundscape, visitor experience, and park operations as beach nourishment activities would last for approximately 18 months every five years. In addition, the placement area would have a larger footprint than under alternative B-1 due to the larger volume of material that would be placed. Under alternative B-5, fish life-cycles would be interrupted due to the longer duration (approximately 18 months every five years) for nourishment placement.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency). Under Alternative C-1, short-term, adverse impacts on the natural aquatic and terrestrial habitats for plants and animals, threatened and endangered species and species of concern, the park soundscape, visitor experience, and park operations would occur during the beach nourishment activities.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five-Year Frequency). Under Alternative C-5, there would be short-term, adverse impacts on terrestrial habitat for plants and animals, threatened and endangered species and species of concern, the natural soundscape of the park, aquatic fauna, visitor experience, and park operations. There would also be long-term adverse impacts on native aquatic fauna from the duration (approximately 10 months every five years) of placement activities (i.e., fish would be displaced for under a year but fish life cycles would be interrupted).

Alternative D (Beach Nourishment via Permanent Bypass System). Under alternative D, short-term, adverse impacts on the natural aquatic and terrestrial habitats for plants and animals, as well as the park soundscape, threatened and endangered species and species of concern, visitor experience, and park operations would occur during ongoing beach nourishment activities and during construction of the permanent bypass system. Long-term adverse impacts would also result from the actions associated with this alternative from the visual intrusion the small lift stations would introduce in to the park, and from the additional staff time and operating dollars the routine monitoring and maintenance of the permanent bypass system would require.

Alternative E (Submerged Cobble Berm and Beach Nourishment, Annual Frequency) – Preferred Alternative. Under the preferred alternative, there would be short-term, adverse impacts on the natural aquatic and terrestrial habitats for plants and animals, the park soundscape, threatened and endangered species and species of concern, visitor experience, and park operations during the construction of the submerged cobble berm, as well as during beach nourishment activities. There would also be long-term adverse impacts from the visual intrusion the submerged cobble berm would introduce into the park and the safety concerns it would pose to boaters before dissipation (though the park would consider implementing mitigation measures to offset these safety concerns).

For the impacts mentioned above for reaches 1 and 2, the mitigation measures described in "The Alternatives" chapter, would help minimize, but not eliminate, these impacts.

Reaches 3 and 4

Alternative A (No-action Alternative). Under the no-action alternative, erosion of the shoreline would continue to occur in reach 3, threatening aquatic and terrestrial habitats and the sediment budget deficit would also continue, resulting in a deficit of material for foredune and dune formation. Taking no new actions in the park would result in continued erosion and destabilization of terrestrial habitat for plants and animals (thus adversely affecting threatened and endangered species and species of concern, as well) and would not improve the ability of the beach to withstand storm events. Short-term, adverse impacts on the natural soundscape would continue during current beach nourishment activities and during high-use times (e.g., summer weekends and holidays)

under the no-action alternative. Visitors would continue to be adversely impacted by ongoing beach nourishment activities from the temporary beach closings and ongoing degradation of popular visitor amenities that result from shoreline erosion. Aquatic fauna would continue to be adversely affected under the no-action alternative from temporary displacement due to turbidity and the benthic fauna that would be smothered during placement of sediment; additionally, current nourishment activities would result in a disrupted environment which would continue to allow for the introduction and/or establishment of invasive and nonnative aquatic species. Park operations would continue to be adversely impacted from the ongoing workload demands and maintenance costs associated with existing beach nourishment activities and shoreline erosion.

Alternative C-1 (Beach Nourishment via Dredged Sources, Annual Frequency). Under alternative C-1, short-term, adverse impacts on the natural aquatic and terrestrial habitats for plants and animals, threatened and endangered species and species of concern, park soundscape, visitor experience, and park operations would occur during the beach nourishment activities.

Alternative C-5 (Beach Nourishment via Dredged Sources, Five Year Frequency) - Preferred Alternative. Under alternative C-5, there would be short-term, adverse impacts on terrestrial habitat for plants and animals, threatened and endangered species and species of concern, the natural soundscape of the park, aquatic fauna, visitor experience, and park operations. There would also be long-term adverse impacts on native aquatic fauna from the duration (approximately six months every five years) of placement activities (i.e., fish would be displaced for under a year but fish life cycles would be interrupted).

Alternative D (Beach Nourishment via Permanent Bypass System). Under alternative D, short-term, adverse impacts on the natural aquatic and terrestrial habitats for plants and animals, as well as the park soundscape, threatened and endangered species and species of concern, visitor experience, and park operations would occur during ongoing beach nourishment activities and during construction of the permanent bypass system. Long-term adverse impacts would also result from the actions associated with this alternative from the visual intrusion the small lift stations would introduce in to the park, from the additional staff time and operating dollars the routine monitoring and maintenance of the permanent bypass system would require.

For the impacts mentioned above for reaches 3 and 4, the mitigation measures listed in "The Alternatives" chapter would help minimize, but not eliminate, these impacts.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

The National Park Service is required to consider if its actions involve an irreversible or irretrievable commitment of resources. A resource commitment is irreversible if it results in loss of resources that cannot be reversed, except perhaps in the extreme long term. Irreversible impacts involve use of and impacts on a non-renewable resource (or a resource renewable only over a long period of time) such that future options for use of that resource are limited. Irretrievable commitments of resources are actions that result in the loss of resources or the consumption of resources that are not renewable or recoverable for future use.

Reaches 1 through 4

For all alternatives presented in this plan / draft EIS there would be an irreversible and irretrievable commitment of resources associated with shoreline restoration activities.

Energy Resources. Energy resources utilized for the proposed action alternatives would be

irreversibly lost. These include petroleum-based products (such as gasoline and diesel) and electricity. During shoreline restoration activities, gasoline and diesel would be used for the operation of heavy equipment, barges, haul trucks, and maintenance vehicles. During terrestrial habitat restoration activities, gasoline would be used for the operation of private and government-owned vehicles. Consumption of these energy resources would not place a substantial demand on these resources or on the availability of them in the region. Therefore, no major impacts would occur.

Human Resources. The use of human resources for shoreline and terrestrial restoration activities would be an irretrievable loss, only in that it would preclude such personnel from engaging in other work activities. The use of human resources for the proposed action would also represent employment opportunities, and would be considered beneficial.

Soil Resources. The loss of soils and sediment due to erosion would be an irreversible commitment of resources under each of the action alternatives presented because it takes so long for soils to form. The proposed action alternatives would also lessen the erosive loss of soils compared to the loss that would occur under the no-action alternatives, and would be considered beneficial in the long-term.

RELATIONSHIP OF SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

The National Park Service is required to consider the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. In doing so, the National Park Service considers the long-term impacts of its actions, and whether its actions involve tradeoffs between immediate use of resources and long-term productivity and sustainability of resources. This analysis examines whether the productivity of park resources would be traded for the immediate use of land.

Reaches 1 through 4

Under any of the action alternatives, the National Park Service would continue to manage the park and its shoreline to maintain ecological processes and native biological communities and to provide appropriate recreational and visitor use opportunities consistent with preservation of natural resources. The park's resources would continue to be protected in their current, relatively natural state to the greatest extent possible, and would maintain their long-term productivity. The primary short-term uses of the shoreline would continue to be recreational/visitor uses.

Under the no-action alternative, continuing adverse impacts on the shoreline and beach and aquatic and terrestrial habitats due to erosion would reduce the productivity of natural resources and processes in localized areas over time, resulting in a large effect on the park's long-term productivity as the erosion of the shoreline would threaten the integrity of natural resources.

Under the action alternatives presented in this plan / draft EIS, these management actions would be implemented to restore coastal and natural processes and terrestrial habitat. Although there would be short- and long-term, adverse impacts that would result from the localized loss of aquatic fauna and terrestrial habitat, overall, no noticeable effect on the park's long-term productivity would result. Conversely, the actions proposed would restore the shoreline and would increase long-term productivity of the shoreline environment through natural processes.