Great Swamp National Wildlife Refuge Wilderness Character Monitoring Summary

The table and the report that follow are part of a national initiative to establish a baseline wilderness character assessment for all of the National Wildlife Refuges with designated wilderness. The measures for each wilderness were developed with refuge staff and reviewed at the national level. This addendum document complements the 2011 report on wilderness character monitoring for Great Swamp National Wildlife Refuge.

Michael Horne 6/1/15

Michael Horne, Refuge Manager, Great Swamp NWR **Date**

6/24/15

Nancy Roeper, National Wilderness Coordinator, NWRS **Date**

Great Swamp NWR Wilderness Character Monitoring Summary Table

The following table summarizes the original measures selected by refuge staff for wilderness character monitoring in 2011 and reflects any modifications that were made in 2015 to comply with the revised monitoring protocol of *Keeping it Wild 2*. The reasoning for adding, removing or modifying measures is explained in the narrative section below the table. This table describes each measure, the quality that it informs, and how often data are collected for the measure. As professionals at the refuge have developed these measures with a Wilderness Fellow, it is expected that these measures will form the basis of wilderness character monitoring in the Inventory and Monitoring Plan that is submitted by the refuge to the region.

Wilderness Character Monitoring Measure attributes for the Great Swamp Wilderness

Quality	Indicator	Measure	Frequency	Data Adequacy	Significant Change	Baseline[1] Value
Untrammeled	Actions authorized by the federal land manager that intentionally manipulate the biophysical environment	Number of person hours spent treating invasive plant species	Annually	High	20	72
		Number of authorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire	Annually	High	Any	0
	Actions not authorized by the federal land manager that intentionally manipulate the biophysical environment	Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire	Annually	High	Any	0
Natural	Plants	Index of invasive non-native plant species	5 years	Medium	Any	98
		Index of native plant species that are listed as endangered, threatened, candidate, or of special concern	5 years	High	Any	0
		Number of extirpated indigenous plant species	5 years	Medium	Any	1
	Animals	Number of invasive non-native wildlife species	5 years	Medium	Any	7

[1] The baseline value is defined as the data value entered into the Wilderness Character Monitoring Database from the first year of available data for a particular measure. An individual measure's baseline year may be different from the baseline year of Wilderness Character Monitoring as a whole.

Quality	Indicator	Measure	Frequency	Data Adequacy	Significant Change	Baseline[1] Value
		Index of native wildlife species that are listed as endangered, threatened, candidate, or of special concern	5 years	High	Any	230
		Number of extirpated indigenous wildlife species	5 years	High	Any	6
		Vernal pool quality	Annually	Medium	25	54 egg masses/ pool
	Air and water	Ozone air pollution	5 years	Medium	Categorical	80.8 ppb
		Total nitrogen wet deposition	5 years	Medium	Categorical	4.8 kg/ha
		Total sulfur wet deposition	5 years	Medium	Categorical	5.8 kg/ha
		Visibility	5 years	Medium	Categorical	12.1 dV
	Ecological processes	Area and magnitude of for pathways for movement of non-native species into wilderness	5 years	High	Any	1415.7 acres
		Percent of landfill acreage remediated	5 years	High	Any	83%
Undeveloped	Presence of non-recreational structures, installations, and developments	Index of authorized physical development	5 years	High	Any	32
	Presence of inholdings	Number of inholdings within wilderness	5 years	High	Any	0 acres
	Use of motor vehicles, motorized equipment, or mechanical transport	Type and amount of administrative and non-emergency use of motor vehicles, motorized equipment, or mechanical transport	Annually	High	Any	6
		Type and amount of emergency use of motor vehicles, motorized equipment, or mechanical transport	Annually	High	Any	0
		Type and amount of motor vehicle,	Annually	Medium	Any	0

Quality	Indicator	Measure	Frequency	Data Adequacy	Significant Change	Baseline[1] Value
Solitude or primitive and unconfined recreation		motorized equipment, or mechanical transport use not authorized by Refuge manager				
	Remoteness from sights and sounds of human activity *inside* wilderness	Area of wilderness affected by access or travel routes that are inside the wilderness	5 years	High	Any	1736 acres
	Remoteness from sights and sounds of human activity *outside* the wilderness	Area of wilderness affected by access or travel routes that are adjacent to the wilderness	5 years	High	Any	2288 acres
	Facilities that decrease self-reliant recreation	Type and number of agency-provided recreation facilities	5 years	High	Any	0
	Management restrictions on visitor behavior	Number and extent of management restrictions	5 years	High	Any	22

Steven Henry, Former Refuge Manager for Great Swamp, and Michael Horne, Current Refuge Manager for Great Swamp participated in the drafting of the new measures and the summary table above.

Narrative

From February to May of 2015 Wilderness Fellow Max Mutter had multiple phone conversations and email correspondences with Steven Henry and Michael Horne to discuss the recent changes in the monitoring framework of *Keeping it Wild 2*. From the discussion, a number of small changes were made from the original 2011 wilderness character monitoring report to comply with the updated version of *Keeping it Wild*.

Untrammeled quality

Indicator:	Actions authorized by the federal land manager that intentionally manipulate the biophysical environment
Measure:	Authorized actions to manage wildlife
Change:	This measure has been removed. The measure only tracked the number of deer that were harvested from the wilderness. While the refuge has determined clear management related reasons for decreasing the deer population within in wilderness that decrease is obtained through public hunting, which has been determined to not constitute a trammeling action.

Indicator:	Actions authorized by the federal land manager that intentionally manipulate the biophysical environment
Old Measure:	Authorized actions to manage vegetation
Change:	The title of this measure has been changed to better reflect what it is measuring. Also, the significant change value has been changed from any to 20.
Updated Measure:	Number of person hours spent treating invasive plant species

Indicator:	Actions authorized by the federal land manager that intentionally manipulate the biophysical environment
Measure:	Number of authorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire
Change:	Some special considerations were made for annual values of this measure that were entered into the database. A large amount of hazard trees were cleared within wilderness in 2013 and 2014 following hurricane Sandy. Although the driving intent of this action was not to manipulate the biophysical environment it was undertaken on such a scale that some amount of biophysical manipulation was expected. Therefore this large scale tree clearing was counted as two trammeling actions (one each in 2013 and 2014), though smaller scale tree clearing generally does not constitute a trammeling.

Natural quality

Indicator:	Plants
Old Measure:	Number of invasive non-native species

Change:	This measure represented the Plants and animal species and communities indicator in the original 2011 report. Refuge staff have identified both plant and animal invasive species within wilderness and have thus decided to include an invasive species measurement under both the Plants and Animals indicators. The word index has replaced the word number in the title to better reflect what is being measured. Also, the data collection protocol has been slightly modified from the baseline report. See the updated measure description at the end of this document.
Updated Measure:	Index of invasive non-native plant species

Indicator:	Plants
Old Measure:	Number of native wildlife species that are listed as endangered, threatened, candidate, or of special concern
Change:	This measure represented the Plants and animal species and communities indicator in the original 2011 report. Although there are currently no listed plant species within wilderness Refuge staff believe this is a possibility in the future. Therefore it was decided to include a listed species measurement under both the Plants and Animals indicators. Additionally the word index has replaced the word number in the title to better reflect what is being measured. Also, the data collection protocol has been altered to reflect the status of these species within the wilderness. See the updated measure description at the end of this document.
Updated Measure:	Index of native plant species that are listed as endangered, threatened, candidate, or of special concern

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Indicator:	Plants
Old Measure:	Number of extirpated indigenous species
Change:	This measure represented the Plants and animal species and communities indicator in the original 2011 report. The original measure focused on wildlife species due to a lack of plant data. However, plant data has improved and the refuge has since confirmed the Swamp pink (*Helonias bullata*) as extirpated from the wilderness. Therefore it was decided to include an extirpated plants measure. This measure maintains a baseline year of 2011 in order to be consistent with its associated Animals measure although the Swamp pink was not technically confirmed as extirpated in 2011.
Updated Measure:	Number of extirpated indigenous plant species

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Indicator:	Animals
Old Measure:	Number of invasive non-native species
Change:	This measure represented the Plants and animal species and communities indicator in the original 2011 report. Refuge staff have identified both plant and animal invasive species within wilderness and have thus decided to include an invasive species measurement under

	both the Plants and Animals indicators. Also, this measure has been modified to be a simple count of species rather than assigning scores to those species. See the updated measure description at the end of this document.
Updated Measure:	Number of invasive non-native wildlife species

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Indicator:	Animals
Old Measure:	Number of native wildlife species that are listed as endangered, threatened, candidate, or of special concern
Change:	This measure represented the Plants and animal species and communities indicator in the original 2011 report. It was decided to include a listed species measurement under both the Plants and Animals indicators. The word index has replaced the word number in the title to better reflect what is being measured. Also the data collection protocol has been altered to reflect the status of these species within the wilderness. See the updated measure description at the end of this document.
Updated Measure:	Index of native wildlife species that are listed as endangered, threatened, candidate, or of special concern

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Indicator:	Animals
Old Measure:	Number of extirpated indigenous species
Change:	This measure represented the Plants and animal species and communities indicator in the original 2011 report. It was decided to include an extirpated species measure under both the Plants and Animals indicators.
Updated Measure:	Number of extirpated indigenous wildlife species

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Indicator:	Animals
Measure:	Vernal pool quality
Change:	The data collection protocol for this measure was updated to reflect the fact that varying numbers of vernal pools are surveyed each year. This was accomplished by changing the measure value unit from number of egg masses to number of egg masses per pool. See the updated measure description at the end of this document. Additionally, the significant change value was changed from any to 25.

Indicator:	Air and water
Old Measures:	Visibility based on average deciview and sum of anthropogenic fine nitrate and sulfate, Ozone air pollution based on concentration of N100 episodic and W126 chronic ozone exposure affecting sensitive plants, and Acid deposition based on concentration of sulfur and nitrogen in wet deposition
Change:	These three air quality measures have been reorganized into four measures in order to be

consistent with national air quality monitoring protocols.

Updated Measures: Ozone air pollution, Nitrogen total wet deposition, Sulfur total wet deposition, and Visibility

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Indicator: Ecological processes
Old Measure: Extent and magnitude of global climate change

Change: This measure was under development at the time of the baseline report and has not yet been implemented and has thus been removed. However, the original measure aimed to monitor phenology as one of its components. The new CCP and monitoring frameworks from the National Phenology Network (NPN), a partner of the US Fish and Wildlife Service, may provide impetus for monitoring phenology in the future. Such a Phenology measure is currently under development and would most likely use around 10 indicator species and the NPN's status monitoring protocol (https://www.usanpn.org/about/approach). See the possible measure description at the end of this document.

Updated Measure: Phenology (under development)

Undeveloped quality NO CHANGES

Solitude or primitive and unconfined recreation quality

Indicator: Remoteness from sights and sounds of human activity *inside* wilderness
Old Measure: Amount of visitor use

Change: This measure was under development at the time of the baseline report and has not yet been implemented due to lack of resources. Therefore it has been removed for the purposes of this update, but could be implemented in the future if resources allow for dependable data collection.

Indicator: Remoteness from sights and sounds of human activity *inside* wilderness
Old Measure: Number of trail contacts

Change: This measure was under development at the time of the baseline report and has not yet been implemented due to lack of resources. Therefore it has been removed for the purposes of this update, but could be implemented in the future if resources allow for dependable data collection.

Indicator: Remoteness from sights and sounds of human activity *outside* the wilderness
Old Measure: Number of trail contacts

Change: This measure was under development at the time of the baseline report and has not yet been implemented due to lack of resources. Therefore it has been removed for the purposes of this update, but could be implemented in the future if resources allow for dependable data collection.

Indicator:	Remoteness from sights and sounds of human activity *outside* the wilderness
Old Measure:	Average amount of time that intrusions on the natural soundscape are heard from within wilderness
Change:	This measure was under development at the time of the baseline report and has not yet been implemented due to lack of resources. Therefore it has been removed for the purposes of this update, but could be implemented in the future if resources allow for dependable data collection.

Other features of value quality

Indicator:	Deterioration or loss of integral historic or cultural features
Old Measure:	Number and severity of disturbances to cultural resources
Change:	This measure was included under the old required Loss of statutorily protected cultural resources indicator. Cultural resources have now been moved to the optional Other features of value indicator. In light of this change the refuge has decided to remove the measure, as no cultural resources of consequence exist within the wilderness.

Measure: Index of invasive non-native plant species

Background & Context: (copied from the baseline report) The Wilderness Area may serve as a place where populations of sensitive plant and wildlife species can find some measure of protection. A decrease in this value over time could be caused by actions not under the control of a wilderness manager, but are impacts to naturalness nonetheless. Invasive non-native species are a concern of the Wilderness Area. Refuge staff will determine which species are considered invasive.

Measure Description & Collection Protocol: Refuge staff determine which non-native plant species within wilderness should be considered invasive. Each species is given two scores based on the scores table below. The first score relates to abundance and estimates the percentage of the wilderness in which the species is found. The second score estimates the local density of the species where it is found within wilderness. All of these scores are added together to reach the final measure value.

Data Source: Refuge Biologist and/or Biological Science Technician

Data Adequacy: Medium. It is possible that there are some unknown invasive species within the wilderness.

Frequency: Annually

Significant Change: Any change in the value of this measure is considered significant.

Scores for the index of invasive non-native plant species measure			
Abundance		Local density (where present)	
Score	% of wilderness where species is present	Score	Description
1	>10%	1	Only scattered individuals
2	10-20%	2	Some small clumps of species
3	21-40%	3	Species prevalent but not dominant
4	41-60%	4	Dominant species of the area
5	<60%	5	Species approaching 100% density

Baseline value for the index of non-native invasive plant species measure at the Great Swamp Wilderness			
Species	Abundance score	Local density score	Total score
Japanese stiltgrass	5	5	10
Japanese barberry	3	5	8
Japanese knotweed	2	5	7
Canada thistle	1	3	4
Phragmites australis	3	5	8
Russian olive	1	3	4
Autumn olive	1	3	4
Japanese honeysuckle	1	3	4
Tartarian honeysuckle	1	3	4
Garlic mustard	3	5	8

Multiflora rose	4	5	9
Purple loosestrife	2	3	5
Oriental bittersweet	1	3	4
Chinese lespedeza	1	3	4
Ailanthus altissima	1	1	2
Chinese silvergrass	4	1	5
Winged burning bush	3	3	6
Oriental photinia	1	1	2
		Total	**98**

Measure: Number of invasive non-native wildlife species

Background & Context: (copied from the baseline report) The Wilderness Area may serve as a place where populations of sensitive plant and wildlife species can find some measure of protection. A decrease in this value over time could be caused by actions not under the control of a wilderness manager, but are impacts to naturalness nonetheless. Invasive non-native species are a concern of the Wilderness Area. Refuge staff will determine which species are considered invasive.

Measure Description & Collection Protocol: Every 5 years the number of invasive non-native wildlife species known to be within the wilderness is counted.

Data Source: Refuge Biologist and/or Biological Science Technician

Data Adequacy: Medium. It is possible that there are some unknown invasive species within the wilderness.

Frequency: Every 5 years

Significant Change: Any change in the number of invasive non-native wildlife species is considered significant.

Baseline value for the Number of invasive non-native wildlife species in the Great Swamp Wilderness	
Species	
European starling	
House sparrow	
Mute swan	
Brown-headed cowbird	
Feral cat	
Rusty crayfish	
Red-eared slider	
Total	**7**

Measure: Vernal pool quality

Background & Context: (copied from the baseline report) Vernal pools are essential habitat for portions of the life cycles of many species, and are also the favored habitat for considerably more species, particularly amphibians, that use them for breeding and foraging in an area of reduced predation. In New Jersey, seven species are dependent upon vernal pools, including blue-spotted salamander and wood frog. The blue-spotted salamander is a State-listed endangered species. Threats to vernal pool habitat in New Jersey include development, which often results in filling and clearing of surrounding vegetation; change in hydrology due to irrigation wells; overuse of fertilizers and pesticides; and mosquito control efforts.

Measure Description & Collection Protocol: Every year the number of wood frog and blue-spotted salamander egg masses counted during vernal pool surveys within wilderness and the total number of vernal pools surveyed within wilderness is recorded. The final measure value is the number of egg masses per pool, which is found using the following formula:

$$\frac{(\#\text{ of wood frog egg masses}) + (\#\text{ of blue spotted salamander egg masses})}{\#\text{ of vernal pools surveyed}}$$

Data Source: Refuge Biologist and/or Biological Science Technician

Data Adequacy: Medium. Not all vernal pools within wilderness can be surveyed every year, therefore data adequacy is medium.

Frequency: Annually

Significant Change: A change of 25 or more in the number of egg masse per pool is considered significant.

Measure: Index of native plant/wildlife species that are listed as endangered, threatened, candidate, or of special concern

Background & Context: (copied from the baseline report) The Wilderness Area may serve as a place where populations of sensitive plant and wildlife species can find some measure of protection. A decrease in this value over time could be caused by actions not under the control of a wilderness manager, but are impacts to naturalness nonetheless

Measure Description & Collection Protocol: This measure description and protocol refers to two separate measures with identical structures, one the focuses on wildlife that is under the Animals indicator, and one that focuses on plants that is under the Plants indicator. For these measures species that are listed are assigned two scores based on the table below. One score corresponds to the degree of their listed status while the other estimates their status within the wilderness. For the status within wilderness score 2 (fair) is used as a default value if data is lacking. All of these scores are added together to reach the final measure value. Listed species that where within the wilderness and then extirpated are also considered in this measure. A decrease in the number or severity of listed species within wilderness improves the natural quality.

Data Source: (Copied from the baseline report) NJDEP Division of Fish & Wildlife: New Jersey's Endangered and Threatened Wildlife; and NJ Endangered and Nongame Species Program- Special Concern Species Status Listing (2008); and U.S. Fish and Wildlife Service Threatened and Endangered Species System.

Data Adequacy: Medium. Species status within the wilderness is an approximate estimation.

Frequency: Every 5 years

Significant Change: Any change in the value of this measure is considered significant.

Scores for the index of native species that are listed as endangered, threatened candidate, or of special concern			
Listing status		Status within wilderness	
Score	Description	Score	Description
1	Species of special concern	1	Good – healthy population
2	Candidate	2	Fair – present at below optimum levels
3	Threatened	3	Poor – present in very small numbers
4	Endangered	4	Extirpated – extirpated from wilderness

Baseline value for the index of native species that are listed as endangered, threatened candidate, or of special concern - PLANTS
Currently there are no listed plant species within the wilderness.

Baseline value for the index of native species that are listed as endangered, threatened candidate, or of special concern - ANIMALS							
Species	Listing score	Status score	Total Score	Species	Listing score	Status score	Total Score

Indiana bat	4	1	5	Common moorhen	1	2	3
Bog turtle	3	2	5	Common nighthawk	1	2	3
American bittern	4	2	6	Eastern meadowlark	1	2	3
Peregrine falcon	4	2	6	Golden-winged warbler	1	2	3
Pied-Billed grebe	4	2	6	Grasshopper sparrow	1	2	3
Red-shouldered hawk	4	1	5	Gray-cheeked thrush	1	2	3
Bald eagle	3	2	5	Great blue heron	1	2	3
Bobolink	3	3	6	Hooded merganser	1	2	3
Cooper's hawk	3	1	4	Horned lark	1	2	3
Yellow-crowned night heron	3	2	5	Kentucky warbler	1	2	3
Barred owl	3	1	4	King rail	1	2	3
Long-eared owl	3	2	5	Least bittler	1	2	3
Red-headed woodpecker	3	2	5	Least flycatcher	1	2	3
Wood turtle	3	1	4	Little blue heron	1	2	3
Blue-spotted salamander	4	1	5	Northern goshawk	1	2	3
Eastern cougar	4	4	8	Northern harrier	1	2	3
Gray wolf	4	4	8	Semipalmated sandpiper	1	2	3
Henslow's sparrow	4	4	8	Sharp-shinned hawk	1	2	3
Sedge wren	4	4	8	Short-eared owl	1	2	3
Bobcat	4	4	8	Snowy egret	1	2	3
American kestrel	1	2	3	Sora	1	2	3
Barn owl	1	2	3	Spotted sandpiper	1	2	3
Black-billed cuckoo	1	2	3	Veery	1	2	3
Black-crowned night heron	1	2	3	Virginia rail	1	2	3
Broad-winged hawk	1	2	3	Wood thrush	1	2	3
Brown thrasher	1	2	3	Yellow-breasted chat	1	2	3
Cattle egret	1	2	3	Eastern box turtle	1	2	3
Cerulean warbler	1	2	3	Spotted turtle	1	2	3
Cliff swallow	1	2	3	Fowlers toad	1	2	3
						Total	**230**

Measure: Phenology

Background & Context: A changing climate brings with it changes in the timing of plant life cycles. Changes in phenology can have wide reaching effects on other ecological processes and thus have the potential to greatly influence the character of the wilderness.

Measure Description & Collection Protocol: This measure utilizes photo points selected for their view of deciduous tree species. Photos are taken at these photo points in a schedule that facilitates the observation of three events; 1) when vegetation first starts to green, 2) the peak greening of vegetation, and 3) when vegetation begins to go dormant (drop leaves). A date is assigned to each of these events at each monitoring period. To ascertain change the number of days each event has shifted between monitoring periods is added together. For example, if initial greening and peak greening each shift 2 days and initial dormancy shifts by 4 days, the total change would be 8 days.

Data Source: Photo points

Data Adequacy: Medium. This protocol gives a decent sense of timing changes at a coarse scale, but does not look at individual plants.

Frequency: Every 5 years

Significant Change: 25 total days is considered a significant change.

Great Swamp NWR Wilderness Character Monitoring Data Update

As part of this process the most current data relating to wilderness character monitoring at Great Swamp was compiled. The following table reflects all of the measure values calculated from data collected from the creation of the baseline report in 2011 until the completion of this update in 2015. The following data should also be entered into the wilderness character monitoring online database.

Updated Wilderness Character Monitoring Measure data for Great Swamp NWR Wilderness

Quality	Measure	Frequency	Baseline Year	Measure Values			
				2011	2012	2013	2014
Untrammeled	Number of person hours spent treating invasive plant species	Annually	2012		72	42	37
	Number of authorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire	Annually	2012		0	1	1
	Number of unauthorized actions to manipulate plant, wildlife, insects, fish, pathogens, soil, water, or fire	Annually	2012		0	0	0
Natural	Index of invasive non-native plant species	5 years	2011	98			
	Index of native plant species that are listed as endangered, threatened, candidate, or of special concern	5 years	2011	0			
	Number of extirpated indigenous plant species	5 years	2011	1			
	Number of invasive non-native wildlife species	5 years	2011	7			

Quality	Measure	Frequency	Baseline Year	Measure Values			
				2011	2012	2013	2014
	Index of native wildlife species that are listed as endangered, threatened, candidate, or of special concern	5 years	2011	230			
	Number of extirpated indigenous wildlife species	5 years	2011	6			
	Vernal pool quality	Annually	2012		54 egg masses/pool	111 egg masses/pool	228 egg masses/pool
	Ozone air pollution	5 years	2009	80.8 ppb			
	Total nitrogen wet deposition	5 years	2009	4.8 kg/ha			
	Total sulfur wet deposition	5 years	2009	5.8 kg/ha			
	Visibility	5 years	2009	12.1 dV			
	Area and magnitude of for pathways for movement of non-native species into wilderness	5 years	2011	1415.7 acres			
	Percent of landfill acreage remediated	5 years	2011	83%			
Undeveloped	Index of authorized physical development	5 years	2011	32			
	Number of inholdings within wilderness	5 years	2011	0 acres			

Quality	Measure	Frequency	Baseline Year	Measure Values			
				2011	2012	2013	2014
	Type and amount of administrative and non-emergency use of motor vehicles, motorized equipment, or mechanical transport	Annually	2012		6	10	4
	Type and amount of emergency use of motor vehicles, motorized equipment, or mechanical transport	Annually	2012		0	2	0
	Type and amount of motor vehicle, motorized equipment, or mechanical transport use not authorized by Refuge manager	Annually	2012		0	1	1
Solitude or primitive and unconfined recreation	Area of wilderness affected by access or travel routes that are inside the wilderness	5 years	2011	1736 acres			
	Area of wilderness affected by access or travel routes that are adjacent to the wilderness	5 years	2011	2288 acres			
	Type and number of agency-provided recreation facilities	5 years	2011	0			
	Number and extent of management restrictions	5 years	2011	22			