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The Coastal Benefits of Watershed Protection

A Florida Framework to Evaluate Proposed Projects

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Why Watershed Protection?

Florida's coast is dynamic, highly productive, and severely threatened, in part because its beauty and natural resources strongly attract humans, their activities, and their needs. Coasts are products of the watersheds that create them through appropriate quantity, quality, and timing of freshwater, sediments and nutrients. When the ancient processes and flows that create coasts are disrupted, coastal health declines. Species move between watersheds and coasts while completing their life cycle activities; habitats undergo generational shifts as sea levels rise and fall over millenia, and these linkages inexorably tie the health of coasts to their watersheds. What initially seems counter-intuitive, protecting habitat at remove from the coast, is vital to the integrity of coastal habitats. Investing in protection of the watersheds which feed and buffer Florida's coasts is critical to coastal protection and restoration.

Table 1 Coastal Benefits of Inland and Upland Protection

REASONS TO PROTECT INLAND & UPLAND HABITAT	BENEFITS TO COASTS
Maintain ecosystem services including flood attenuation, aquifer recharge, carbon sequestration, water filtration, and nutrient removal	Improved air quality
Watershed protection benefits coastal health	Improved water quality
Respond to and reduce regional threats	Reduced invasive species
Adapt to global threats	Improved hydrology to more closely mimic natural water flow regimes
Maintain ecological processes critical to coastal health	Species and marsh migration corridors, and storms and sea level rise refugia

SOLUTIONS FOR A THREATENED COAST

Fortunately, tools do exist to address these needs and threats. Land protection through purchase, conservation easements, and other agreements can be used strategically to buffer and benefit coastal habitats. Restoration of upland habitats can reduce the threats that enter the coastal zone and increase the health of those buffer areas. Planning for marsh migration and removal of barriers also give the coast and her denizens a place to retreat, allowing adaptation to the global threat of sea level rise. These strategies that focus on inland and upland habitats will buffer coastal species, coastal communities, and coastal habitats from current and future threats and reduce their severity, ensuring that Florida's future coast is more adaptable, resilient and sustainable.

GUIDANCE ON CRITERIA FOR INLAND AND UPLAND HABITAT PROTECTION AND RESTORATION TO MAXIMIZE BENEFITS TO COASTAL HABITATS

Decision makers tasked with coastal restoration have an obligation to transparency and accountability, and must be able to justify the expenditure of restoration dollars on all the projects that they support. While habitat protection and restoration projects high in a watershed may have extraordinary coastal benefits, the number of potential projects increases exponentially at increasing distances from the coast. Additionally, the benefit of these proposed projects may not be as intuitive, and thus, may seem harder for decision makers to support. Nevertheless, strategic inland protection and restoration of watersheds is essential to long-term coastal health. Accordingly, we propose criteria which may help evaluate the coastal benefit of inland habitat projects (acquisition or restoration) in Table 2. Further, we have provided a hypothetical rubric which weights these criteria as an example of how projects could be compared based upon their coastal benefits. These criteria and weights were developed through a literature survey; the resources cited at the end of this document may prove of additional use to decision makers and coastal conservation practitioners interested in learning more.

The Need for Coastal Protection and Restoration

While coastal habitats and the species they support may be protected and restored directly on the coast, it also makes sense to focus habitat and species protection and restoration efforts further upland (DWH Trustees 2016). Coasts face tremendous threats and stresses from outside their immediate boundaries, both from oceans and from inland sources. The best way to relieve many of those threats is at their source, which may be many miles inland or upland from beaches, dunes, islands, or marshes under siege. A hyperlocal focus of coastal protection and restoration in the face of regional threats such as poor water quality or quantity and global threats such as sea level rise, will result in a failure to fully support the coast of Florida, her water and air quality, her astonishing biological productivity, and her many and threatened plants, animals and birds that may need inland areas for refuge or to complete their full life cycle.

ECOLOGICAL WEALTH AND VULNERABILITY

Coasts, like other ecotones, or areas of transition between distinct habitat types, may be good indicators of ecosystem health because species within ecotones tend to be living close to the edges of their tolerance of environmental conditions (Yarrow and Martin 2007), and may be the first to show population declines or evidence of stress. Ten of the 39 species of shorebirds that regularly use the Gulf of Mexico as part of their range are considered species of conservation concern by the Gulf of Mexico Avian Monitoring Network (Brush et al. in press), an indication that they are being harmed by stressors in their range.

THREATS, HISTORIC AND EMERGING

Because of their productivity, beauty, and cultural connotations for humans, coasts attract a disproportionate share of the human population both as residents and as visitors. Florida's white sand beaches, clear waters, and ample opportunities for recreation have resulted in Florida being the first state to break the 100 million mark in tourists in 2015 (Dineen 2016), with rapid increases each year despite sometimes significant environmental problems. In the first half of 2018 alone, 65.5 million tourists visited Florida (VISIT FLORIDA Research 2018).

Human population and activity bring economic benefits but also increase the number and magnitude of threats to ecosystems, habitats, and species. Florida's coast is affected by all major anthropogenic threats, including residential and commercial development, agriculture and aquaculture, energy production, transportation and service corridors, biological resource use, human intrusions and disturbance, natural systems modifications, invasive and other problematic species, pollution, and climate change and severe weather (Salafsky et al. 2008). Local threats, such as disturbance to beach-nesting birds and invasive species, may be addressed by *in situ* conservation, but this alone will not result in a vibrant, healthy coast.

Regional threats, such as air and water pollution, must be addressed at the source to protect the coast, and these threats that start inland affect the coasts that drain watersheds. Today, blue-green algal blooms that originate at inland sources are devastating birds and wildlife and endangering human health. Yet land acquisition inland, and water management projects such as elements of Everglades restoration, would improve water quality downstream and help water managers improve timing and quantity of water delivery to coastal ecosystems (Driscoll et al. 2012).

While global threats like climate change must be managed at a global level, adaptation may help protect biodiversity in the face of even global threat (Atzori and Fyall 2018). Because many of the immediate consequences of climate change affect weather events, likely increasing the frequency, duration, and intensity of rainfall, river flooding, winter storms, and hurricanes, a resilient coast is one that is able to shift geographically in response to sea level rise, to absorb nutrients, sediments, and water flows, and to adapt to rapid changes. Coasts have historically shifted and migrated in response to changing sea levels, nutrients, and biophysical habitat creation and destruction processes. At a minimum, healthy coasts need barrier-free spaces to which they can shift, particularly if coastal habitats must retreat rapidly in response to accelerating sea level rise (Donnelly and Burtness 2001).

The Benefits of Inland and Upland Habitat Protection and Restoration

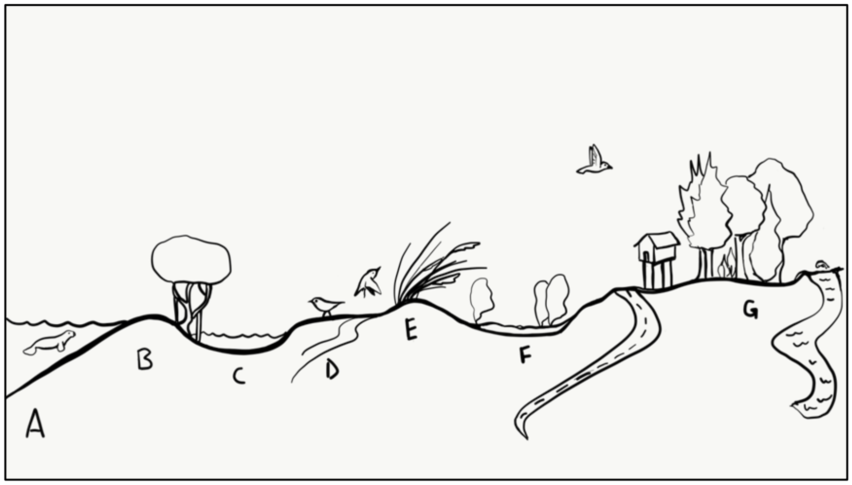

Figure 1: Protection and restoration of inland habitats improves water quality for manatees (A) and other marine life. Delivers sediment and freshwater to maintain barrier islands (B) and appropriate salinity in bays (C). Reduces algal blooms and the impact of red tides, improving survival of coastal shorebirds (D) and other coastal life. Reduces invasive species on dunes (E) and in marshes (F). Allows for marsh migration inland if barriers presented by the built environment can be modified (G). Forests (G) sequester carbon and reduce air pollution, while also providing species migration corridors and refuge for species during storms and sea level rise. Drawing by Toni Taylor.

Protection and restoration of inland and upland habitat parcels will directly and indirectly benefit Florida's coast if implemented strategically (DWH Trustees 2016). Evaluation of current habitat type and ecological value, investigation of ecosystem services provided by candidate parcels, and thoughtful consideration of how parcels may contribute to maintenance or restoration of ecological processes and maintenance of biodiversity will maximize the benefit of watershed conservation to downstream ecosystems, habitats, and species (Bennett et al. 2009). In addition, human communities will benefit as coastal habitats regain vibrancy, tourism and other economic activities are better supported, clean water and air improve health outcomes, and resilient habitats are better able to absorb near-term impacts of climate change and sea level rise.

Specific benefits of inland and upland habitat protection and restoration include improvement of air quality, improvement of water quality, aiding of marsh migration, benefit to migrating species, and maintenance of ecological processes (Figure 1). These benefits include the following:

WATER QUALITY

Acquiring and protecting habitat in a watershed benefits the affected coast by preventing conversion of habitat to development, agriculture, and other surfaces that lack the water filtering capacity of native habitat types. Not only do developed areas, agricultural fields, and small retention ponds and hardened ditches release water quickly, allowing downstream flooding, they also increase erosion and inputs of fertilizers, pesticides, and other nutrients and pollutants into watersheds. As these compounds accumulate toward the coast, they harm water quality, cause algal blooms, and exacerbate red tides. They also cloud waters, reducing foraging efficiency of coastal birds.

Native habitats are more permeable than human-altered habitats, releasing water more slowly and reducing flood risk downstream. Additionally, the permeable surfaces of natural habitats filter and clean water, trapping pollutants and either neutralizing them or keeping them in the soils. Protection, expansion, and restoration of native habitats, particularly wetlands, will improve the quality of water reaching the coast, improve drinking water, and reduce flood severity, frequency, and duration in the lower parts of coastal watersheds. Different habitat types filter water at different rates, and thus have different values for reducing pollution and water filtration. Marshes, swamps and lakes have the capacity to hold vast quantities of water, and are thus excellent choices as habitats to provide flood protection and water quality benefits for coastal areas. Restoration on these habitats adds benefit by increasing their capacity to hold and filter water.

MARSH MIGRATION

To be successful at protecting the coast, a marsh migration strategy must incorporate both land protection to allow spaces into which marshes can migrate and restoration focused on removing or modifying barriers to movement of habitat. Marshes can only move upland where elevations are at levels that will accommodate marsh to exist at the future sea level. Even at accessible elevations, marshes can only move into certain types of habitat. Development at or near the inland edge of a marsh will prevent inland movement through creation of barriers to movement as well as increasing the likelihood of armoring to protect human communities and assets (The Nature Conservancy and NOAA National Ocean Services Center 2011). Restoration to allow marsh migration may include elevating roadways, removing armoring and impermeable structures, or altering habitats to allow marshes to encroach successfully.

While marsh migration has happened for millenia in response to changing environmental conditions including rising and falling sea levels, the current rate of sea level rise is increasing the urgency of planning for marsh migration. As more coastal areas in the United States are suffering the devastating effects of 500 and 1000 year storms, models and tools are being developed rapidly to help coastal and marsh managers plan and respond. For habitat selection purposes, models that can incorporate specific data may be more beneficial, though other tools, such as the National Oceanic and Atmospheric Administration (NOAA) coastal resilience tool, may be more useful for helping a broad audience understand the implications of sea level rise and storm surge (https://coast.noaa.gov/digitalcoast/tools/coastalresilience.html).

SPECIES MIGRATION CORRIDORS

Acquiring inland habitat and restoring it provides food, shelter, and protection for many species of birds and animals that may rely on coasts and inland habitats to fulfill different needs, including species with large home ranges, those whose full cycle encompasses multiple habitat types or regions, and those that need refuge from storms and other events. Inland habitats provide needed connectivity and necessary resources, ensuring the needs of species are met across time and space. For example, successful migration and subsequent reproduction for shorebirds depends on food availability at refueling stops (Krapu et al. 2006), which may include coastal shorelines, barrier islands, wetlands, and impoundments.

To provide maximum benefit, habitat patches must contain appropriate elements such as food and shelter to meet the needs of target species and must have adequate connectivity to other conservation lands. For effective movement between patches and recolonization of habitat patches after local extinctions, both structural and functional connectivity need to be incorporated (Kindlmann and Burel 2008). Animal considerations include gap-crossing ability, dispersal distances, and increased energetic costs as distances between patches grow. Consider plant dispersal distances for propagules and presence of soil seed banks.

Inland Project Types to Achieve Coastal Benefits

Several categories of upland and inland projects can deliver the benefits in Florida that coastal conservation practitioners seek.

INLAND AND UPLAND HABITAT ACQUISITION

Protecting habitats away from the coast prevents them from being converted into other land uses or habitat types, reducing threats, maintaining ecosystem services throughout the watershed, and providing benefit to at-risk coastal species during other parts of their life cycle. Intact habitats retain sediment, reduce pollution, attenuate flood risk, increase biodiversity, improve pollination rates, and sequester carbon, reducing the greenhouse gases contributing to climate change. These sites, particularly wetlands, are critical in the life histories of threatened coastal species. Declining shorebirds may rely on coastal habitats during winter, but also utilize upland marshes or wetlands during migration, for example.

Upland and inland habitats may be protected through a variety of mechanisms, including purchase, conservation easement, or land transfer. Given the duration and scope of the threats to coastal systems, permanent protection is ideal, though long-term protection, preferably more than 20 years, may be helpful. Consideration should be given to the capacity of the land owner or manager to protect the habitat into the knowable future, including resources to regularly assess and address threats. Inland habitats should be assessed for restoration need and potential prior to a decision to protect them, with prioritization given to those that require little restoration or have great restoration potential. The land protection community has many resources available about various aspects of property assessment, acquisition or protection, maintenance, and planning documents. It is important to ensure that lands are evaluated for ecological benefits before the process of locating willing sellers commences (Florida Forever 5 Year Plan 2018).

INLAND AND UPLAND HABITAT RESTORATION

Existing restoration techniques provide downstream benefits to coastal areas as well as improving the structure and function of upland habitat parcels. Habitat restoration may include replanting of native vegetation, removal of invasive species, or re-introduction of practices that maintain habitat such as fire management. Restoration of processes such as hydrologic flow should be designed with downstream effects as a key outcome. Restoring water flow regimes will improve the delivery of water, sediment, and nutrients in a way that maximizes the quantity, quality, timing, and location of these resources. Ideally, excess nutrients can be sequestered before they reach the coast, reducing the frequency and severity of algae blooms. In addition to benefits to the upland site, restoration of water flows should reduce flood risk downstream.

Removal or reconfiguration of manmade barriers to habitat migration will help ensure connectivity between upland parcels and coastal habitats. Where barriers cannot be completely removed, efforts to make them more permeable, to raise roadways or other linear features, or to create corridors through hard-scaped areas will allow for migration of marshes. Due to the cost and implications for human communities of these actions, stakeholder input will be necessary. In some instances, these discussions with local communities have instigated those communities to fully recognize the implications of climate change, resulting in planning and partnerships between the environmental and human communities (D. Curson, pers. comm.)

MANAGEMENT OF NUTRIENTS AND POLLUTANTS

Wetlands filter nutrients and pollutants from water, improving water quality throughout the watershed and reducing resulting downstream threats such as harmful algae blooms. Nutrients are reduced through burial in sediments in the wetland, denitrification, and plant uptake (Day et al. 2004). Additional benefit may be accrued by deliberate application of secondarily treated wastewater effluent into wetlands, which has been shown in Louisiana to reduce nitrogen and phosphorus, improving effluent water quality, benefiting the receiving wetland productivity and soil accretion rates, and offsetting water treatment costs (Day et al. 2004). Water retention time, the most significant factor in denitrification of water, should be considered in choosing wetlands to acquire or restore for sewage or pollutant management benefits (Jansson et al. 1994).

Stream restoration is another active restoration technique that reduces nutrients and pollutants going into downstream waters and has the additional benefit of reducing erosion and increasing sediment capture by streams. The rate of nutrient reduction varies greatly across stream restoration projects and also with flow conditions. Stream restoration that incorporates connection to wetland complexes is likely to have greater impact on reducing nutrient loads (Filoso and Palmer 2011). The Natural Resources Conservation Service has funded stream restoration for decades, and is a starting point for understanding the wealth of techniques and strategies available (http://go.usa.gov/BvNA).

FOREST MANAGEMENT AND RESTORATION

Forest protection and timber management benefit coasts by improving water and air quality, providing connectivity and corridors, and providing critical habitats, including food, stopover habitat, shelter, and refuge from storms. Because managed forests may directly contribute to the economy, forests remain extensive, with potential to provide more direct benefits than habitats that do not sustain themselves economically. Extensive root systems trap sediments and uptake water and nutrients, providing erosion control, nutrient capture and management, and sequestering carbon, ultimately reducing the emission of greenhouse gases contributing to climate change. Forest management and restoration will be affected by rapid climate change, as disturbances will increase through changes in the frequency and intensity of droughts, floods, fires, insect and pathogen outbreaks, and introductions of invasive species (Dale et al. 2001). To conserve biodiversity in forests, focus must be on maintenance of connectivity, landscape heterogeneity, stand structure integrity, aquatic ecosystem integrity, and the use of natural disturbance regimes to guide human disturbance regimes (Lindenmayer et al. 2006).

INVASIVE SPECIES REMOVAL

Invasive species removal in upland and inland habitats increases resources and decreases threats both on the target parcel and downstream at the coast. Removing invasives increases the amount and quality of food and other resources by decreasing competition for food and space. Invasive species removal inland may reduce the likelihood and number of individuals and propagules entering habitats at the coast. Removal of old world and Japanese climbing ferns in both upland habitats and forested wetlands reduces threat of fern acting as a fire ladder, thus improving forest health, reducing unplanned fires, and maintaining the ability to hold carbon in trees. Removal of invasive Brazilian pepper and melaleuca species can improve the water storage and cleaning functions of wetlands as well.

While some invasive species will not survive the extremes of coastal habitats, those that become well established may be effectively impossible to eradicate once they invade hydrologic systems. Thus, this strategy should be employed aggressively if implemented in time to eradicate a new invasive species, and in limited ways to reduce particularly virulent threats in other cases. Because of the difficulty and expense, this strategy may rank lower on the list of effective restoration techniques.

FIRE MANAGEMENT AND RESTORATION

Deliberate fire management on fire-dependent or fire-prone habitats can reduce likelihood of larger and more intense fires. Restorations including reduction of tree density and use of surface fire effectively reduce fire hazard and increase carbon storage under future climate and wildfire conditions (Liang et al. 2018). Controlled management reduces ash and the use of polluting fire suppressants, also. In this way, fire management benefits both local and coastal habitats through an improvement in regional air and water quality, and reduces climate change threats. Appropriate fire management is also less intrusive to human communities, reducing resistance to the use of fire as a management tool, and allowing maintenance of grasslands and other native habitats.

Final Considerations for Project Planning

Strategies should be targeted to the key threats, both on the habitats to be restored but also on downstream habitats. Rigorous conservation planning at an appropriate scale is one tool to identify the key biological targets, most important threats, and best partners to manage habitat, site, or area restoration. Habitat protection and restoration are complicated by land tenure and ownership, stakeholder needs, and uncertainties in future land use and environmental conditions, such as the rate of future sea level rise and the dynamic nature of marsh response to sea level rise (Propato et al. 2018). To ensure that upland habitat protection and restoration is successful, conservation planning and evaluation of habitat parcels should be based on reliable data, should utilize trusted modeling techniques, and should incorporate stakeholder and expert input. If the desired benefits are strictly environmental, then expert knowledge and modeling will be sufficient. If benefits to human communities specifically are desired, then a process to incorporate stakeholder input should also be developed.

Climate change is making a brave new world of conservation implementation. With every act of habitat protection and restoration, whether inland, upland, or coastal, consideration must be given to the likelihood of increased frequency and severity of weather events, disturbances, and threats. These realities need to be accommodated; they should not slow our pace of decision-making, but rather increase the urgency with which habitats are selected for protection and restoration. Climates have always changed and organisms have always moved between coastal and inland environments. Particularly in this era of rapidly accelerating climate change, it is critical that habitats be protected both on the coasts and inland, and barriers between them be removed or accommodations made so that both species and habitats can find refuge from the storm, literally and figuratively.

Criteria for Prioritization of Inland and Upland Parcels for Protection and Restoration

Based on a survey of the available literature, we propose a theoretical rubric for scoring candidate parcels for inland and upland protection and restoration to benefit coastal systems. The criteria are grouped by category; each category has a weight, with weights for all categories summing to 1.0. Each criterion is weighted, with criteria weights summing to 1.0 across each category. A parcel can score from 0 (low) to 3 (high) on each attribute, except where the description is no (score = 0) or yes (score = 1). Qualitative or quantitative descriptions of each criterion score are found in Table 2. To score a parcel, identify the best description for the candidate parcel for each criterion and fill out the Parcel Scoring Worksheet (Table 3). Sum all category scores to determine 'Total parcel score'. The minimum possible score for a parcel is 0.0625, while the maximum possible score for a parcel is 2.70. If the user (funder or decision-maker) desires heavier emphasis on given criteria or categories, weights may be altered to reflect the value placed on particular benefits. Weights must total 1.0 for all categories, and for all criteria within each category.

Table 2 Hypothetical Scoring Rubric for Proposals

CATEGORY	WEIGHT	CRITERION	WEIGHT	DESCRIPTION OF EACH CRITERION BY SCORE (0-3)			
				0	1	2	3
Habitat	0.25	Parcel size (acres)	0.25	0	<25	25-50	>50
		Habitat composition	0.25	other	forest/ grassland	wetland	lake/pond
		Threat of conversion	0.5	none	low	medium	high
Water quality/ quantity	0.25	In EPA priority watershed	0.1	no	yes		
		In NRCS priority area	0.1	no	yes		
		Riparian buffer	0.4	no	yes		
		Percent of watershed in parcel	0.4	1-3%	4-7%	8-10%	>10%
Corridors/ migration	0.125	Relation to other conservation lands	0.25	none	1 side connected	2 sides connected	inholding
		Potential for habitat migration	0.5	Hard barrier	Movable barrier	Permeable barrier	No barrier
		Connectivity (distance from other natural areas)	0.25	>5 km	within 5 km	within 1 km	contiguous
Wildlife benefits	0.125	Number of threatened / endangered species	0.5	0	1	2	>2
		Number of Species of Greatest Conservation Need	0.2	0-5	6-10	11-15	>15
		Index of biodiversity	0.2	Informed by data of Florida Natural Areas Inventory			
				none	low	medium	high
		Storm refugia (distance to coast)	0.1	0 km, >100km	5-25 km	26-50 km	<5 km, >50 km
Restoration potential	0.25	Stream restoration	0.5	none	channel restoration	restore & reconnect	mimic natural hydrology
		Wastewater application to wetland (retention time)	0.2	none	short	long	.
		Forest management purpose	0.2	none	timber	multiple benefit	biodiversity
		Invasive exotic species removal	0.1	none	partial, single species	manage exotic species	complete eradication

Table 3 Parcel Scoring Worksheet

CATEGORY	CRITERION	SCORING				PARCEL SCORE		
		0	1	2	3	CRITERION SCORE x	CATEGORY WEIGHT	= CATEGORY SCORE
Habitat	Parcel size	0.00	0.25	0.50	0.75			
	Habitat composition	0.00	0.25	0.50	0.75			
	Threat of conversion	0.00	0.50	1.00	1.50			
					Habitat sum →		0.25	
Water quality/ quantity	In EPA priority watershed	0.00	0.10	0.00	0.00			
	In NRCS priority area	0.00	0.10	0.00	0.00			
	Riparian buffer	0.00	0.40	0.00	0.00			
	Percent of watershed in parcel	0.00	0.40	0.80	1.20			
					Water quality/ quantity sum →		0.25	
Corridors/ migration	Relation to other conservation lands	0.00	0.25	0.50	0.75			
	Potential for habitat migration	0.00	0.50	1.00	1.50			
	Connectivity	0.00	0.25	0.50	0.75			
					Corridors/ migration sum →		0.125	
Wildlife benefits	Threatened & endangered species	0.00	0.50	1.00	1.50			
	Species of Greatest Conservation Need	0.00	0.20	0.40	0.60			
	Index of biodiversity	0.00	0.20	0.40	0.60			
	Storm refugia	0.00	0.10	0.20	0.30			
					Wildlife benefits sum →		0.125	
Restoration potential	Stream restoration	0.00	0.50	1.00	1.50			
	Wastewater application to wetland	0.00	0.20	0.40	0.60			
	Forest management	0.00	0.20	0.40	0.60			
	Invasive exotic species removal	0.00	0.10	0.20	0.30			
					Restoration potential sum →		0.25	
							Sum last column to determine Total Parcel Score →	

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