Facultad de
cfcn
Ciencias Forestales y de la Conservación de la Naturaleza

DIPLOMADO DE POSTÍTULO EN RESTAURACIÓN Y REHABILITACIÓN AMBIENTAL

TERCERA VERSIÓN

6 AGOSTO - 19 NOVIEMBRE, 2011

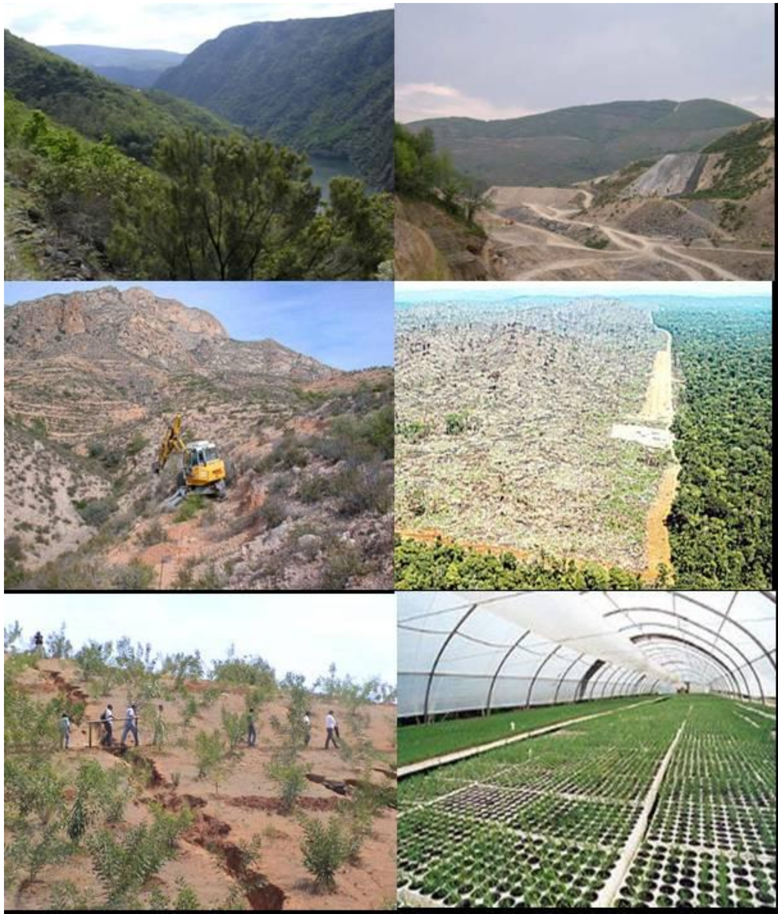
120 HORAS PEDAGÓGICAS

Outline

1. Restauración orientada a procesos

2. Planificación

3. Un ejemplo de plan de restauración



1. Qué significa orientar la restauración a procesos?

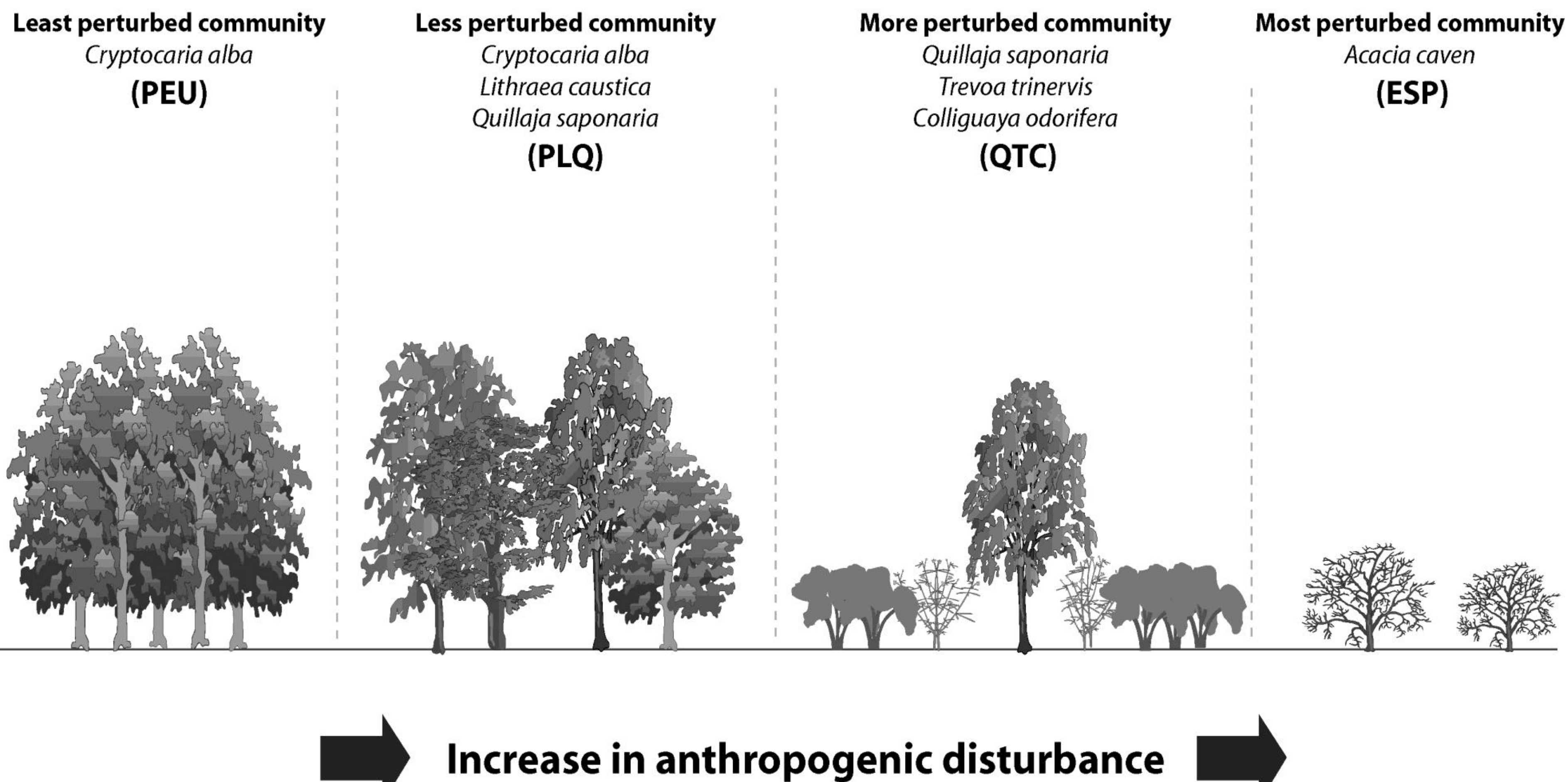
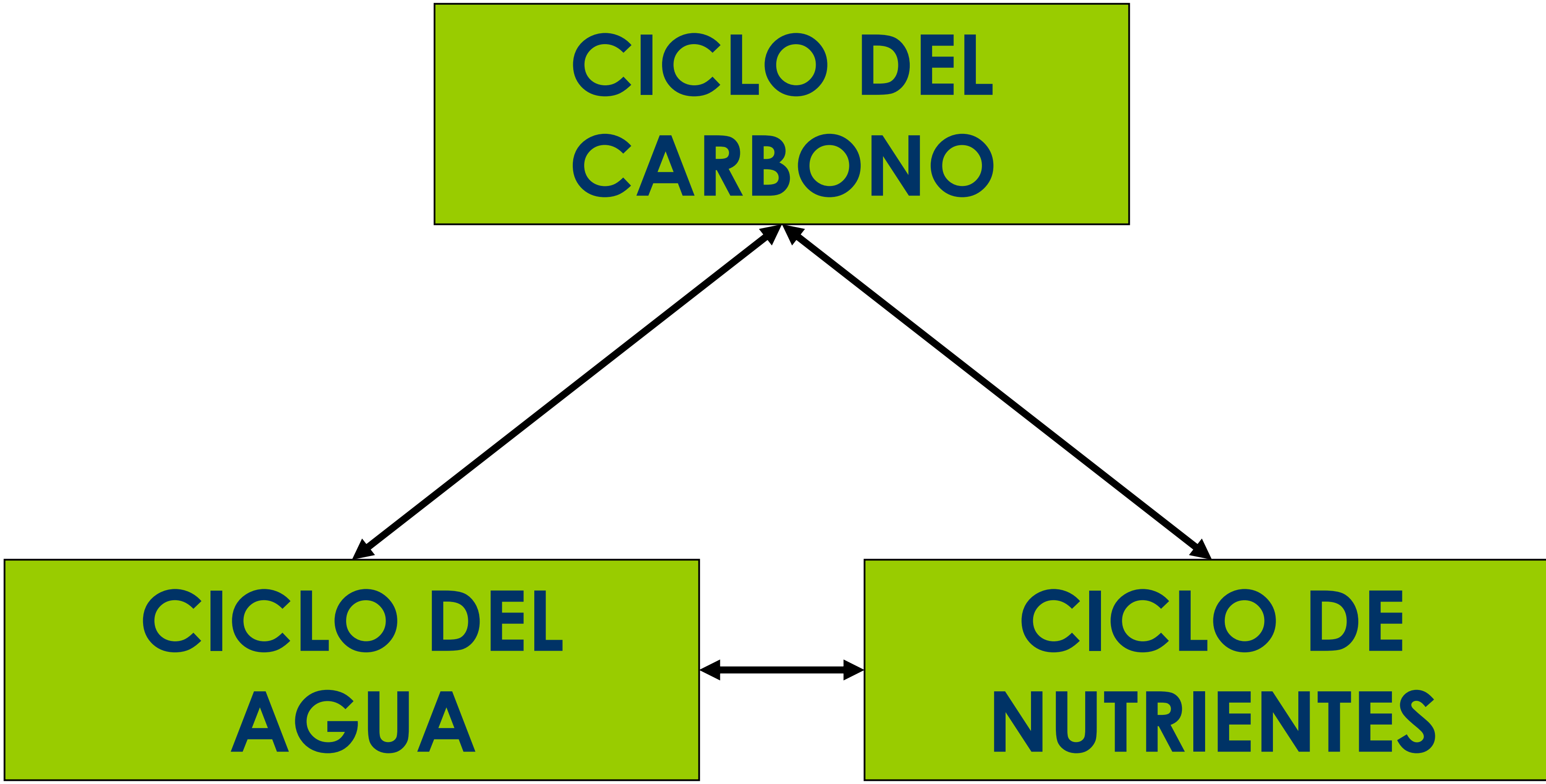


Figure 1. Hypothetical disturbance model in soil and vegetation in schlerophyll ecosystems in Central Chile: (i) savannah of *Acacia caven* (ESP, most disturbed), (ii) shrubland of *Colliguaya odorifera* and *Trevoa trinervis* with sparsed trees of *Quillaja saponaria* (QTC, highly-disturbed), (iii) tree cover of *Lithraea caustica* (Litre)-*Cryptocarya alba-Quillaja saponaria* (PLQ, disturbed), and (iv) *Cryptocarya alba* (Peumo) forest (PEU, mildly disturbed).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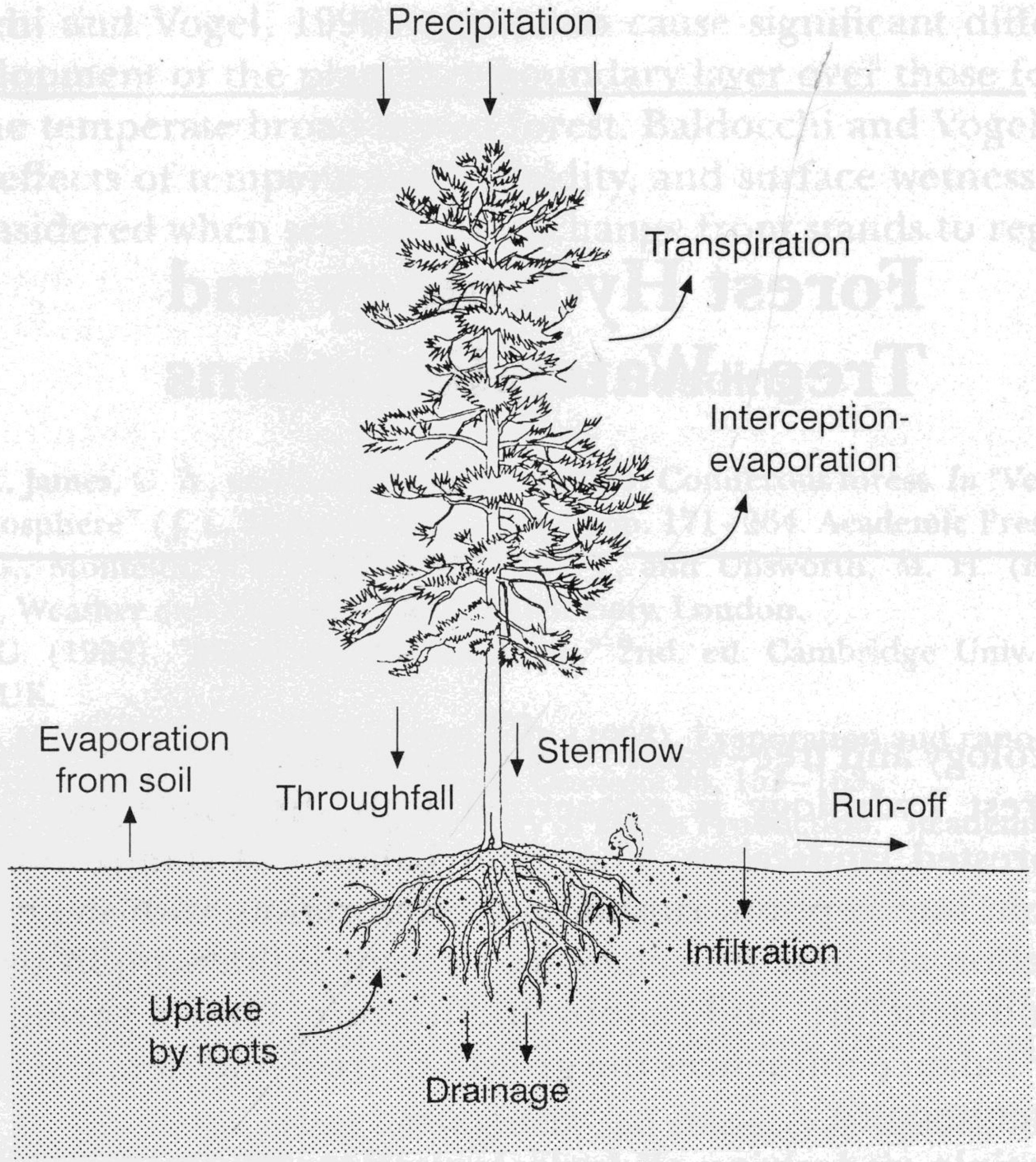
CICLO DEL AGUA
CICLO DE NUTRIENTES

1 CICLO DEL AGUA



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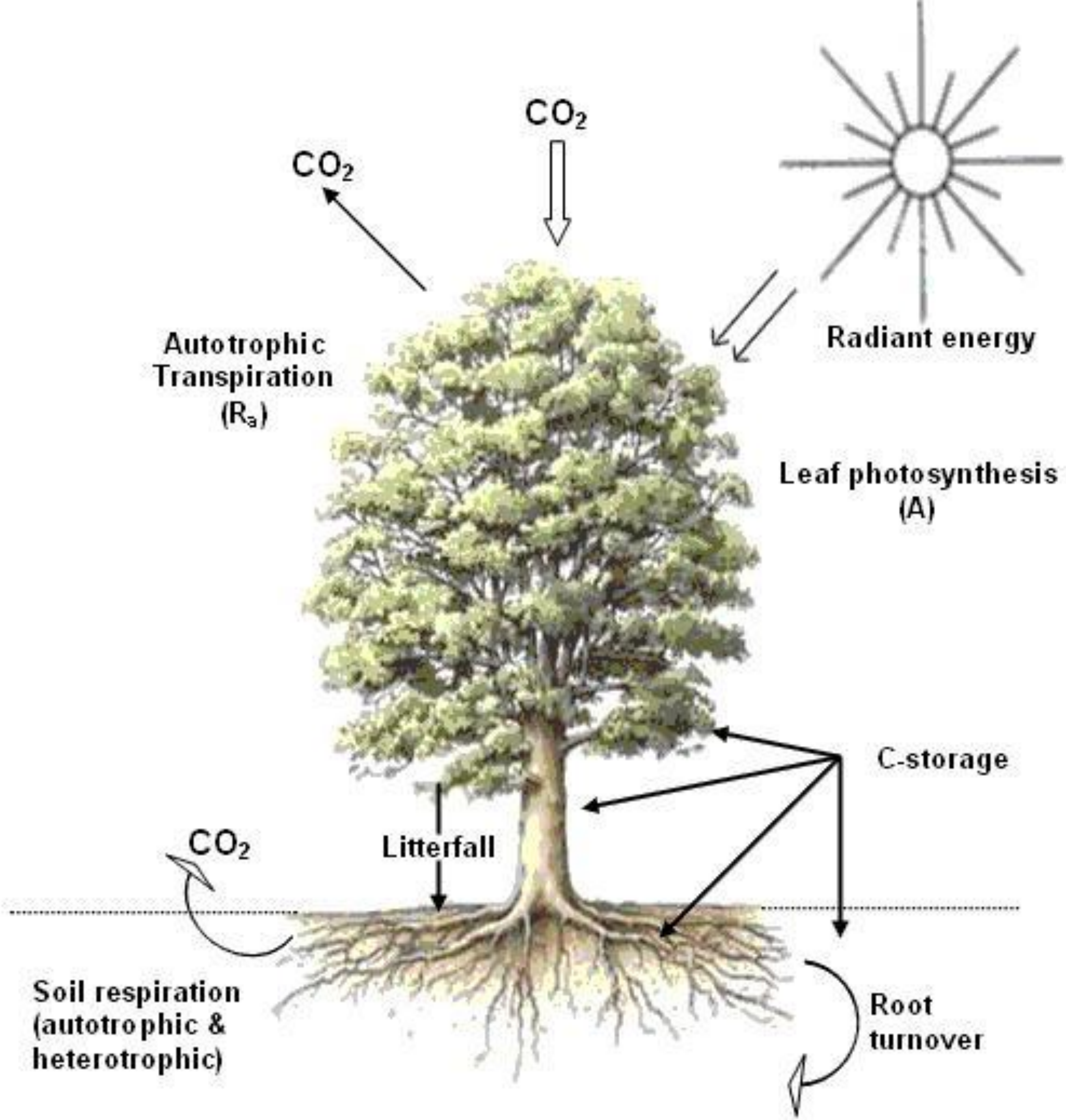

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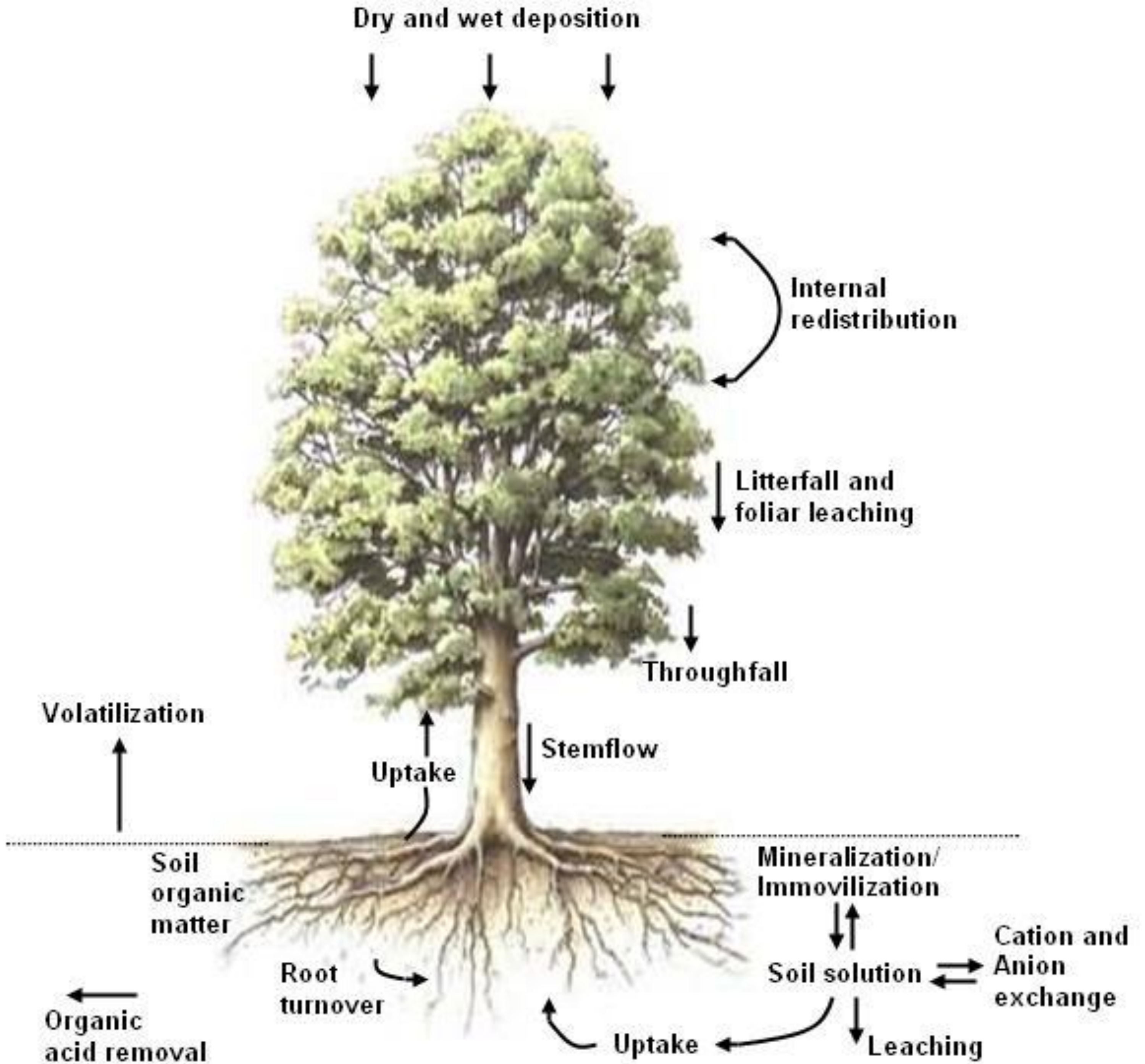


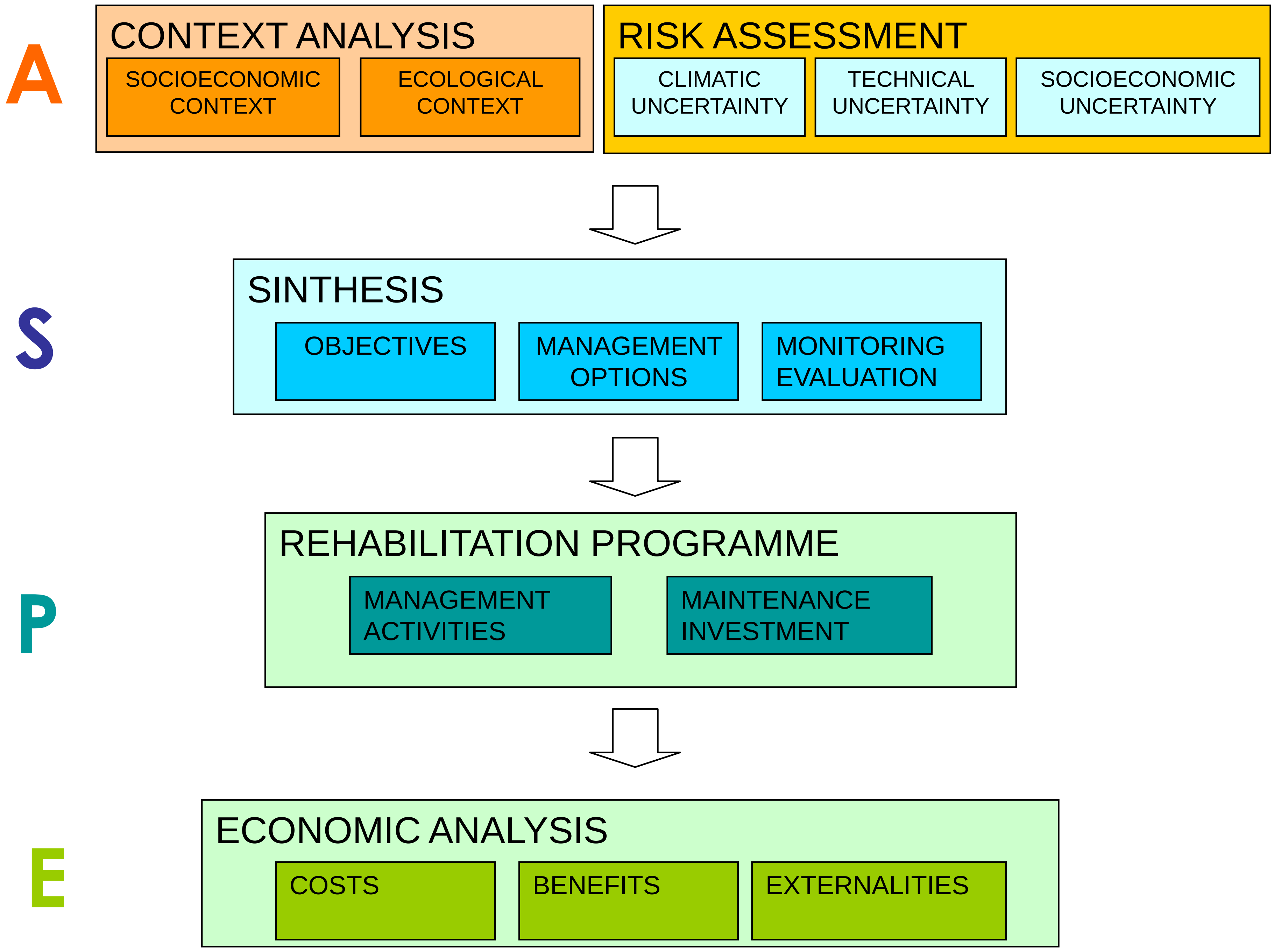
Planificación de la Rehabilitación

- Identificar Objetivos
- Identificar Restricciones
- Desarrollar alternativas para reparar cada uno de los problemas identificados
- Evaluar los riesgos de cada alternativa y sus probabilidades de éxito
- Desarrollar un plan

Planificación de la Rehabilitación

Objetivos Generales

- Lograr ecosistemas plenamente funcionales con capacidad para auto-repararse
- Con mínimos requerimientos de subsidios
- Que consideren la rehabilitación funcional del paisaje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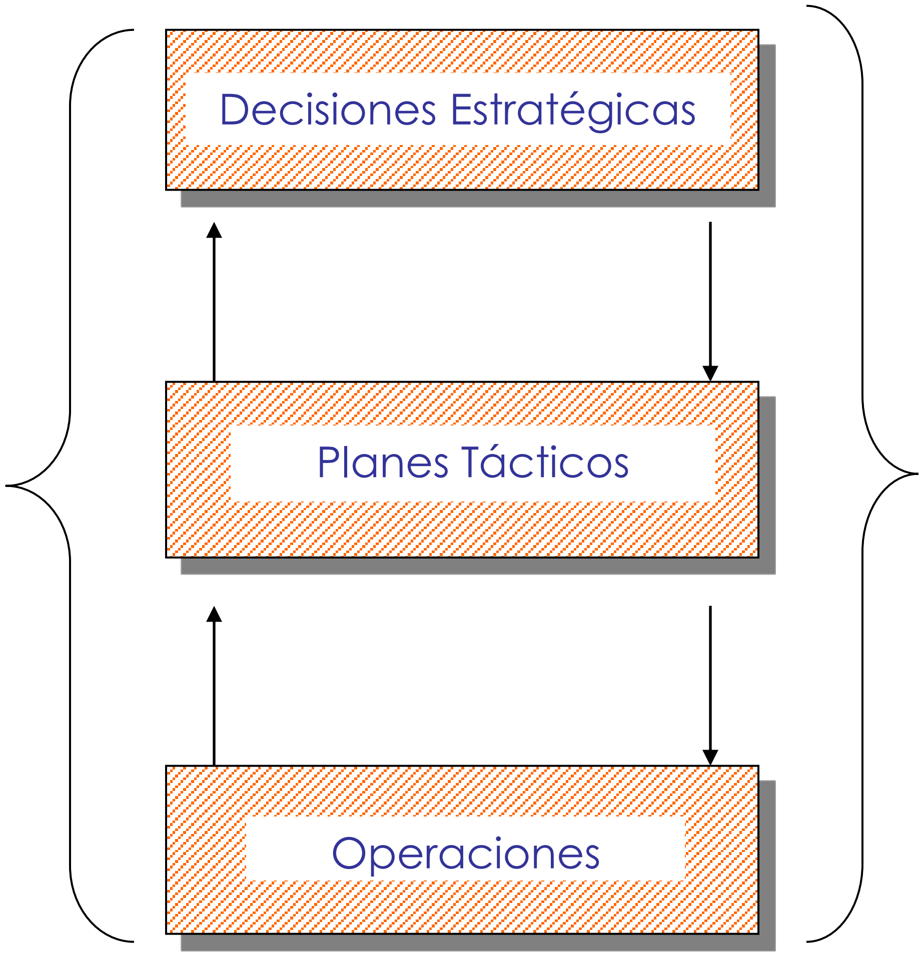
Enfoque Jerárquico en Planificación

Horizonte de Planificación

Grado de Estructuración

Nivel de Quien toma decisiones

Recursos Involucrados



Modelos separados para cada nivel

Horizonte de Planificación Móvil

Reconocimiento explícito de la incertidumbre

Horizonte de Planificación Móvil

Plan de Rehabilitación (A MUST LIST)

1. Racional de por qué se requiere rehabilitar

2. Una descripción ecológica del ecosistema a rehabilitar

3. Declaración de objetivos y metas

4. Una designación y descripción de la referencia

5. Una descripción de cómo la propuesta se inserta en el paisaje

Plan de Rehabilitación (A MUST LIST)

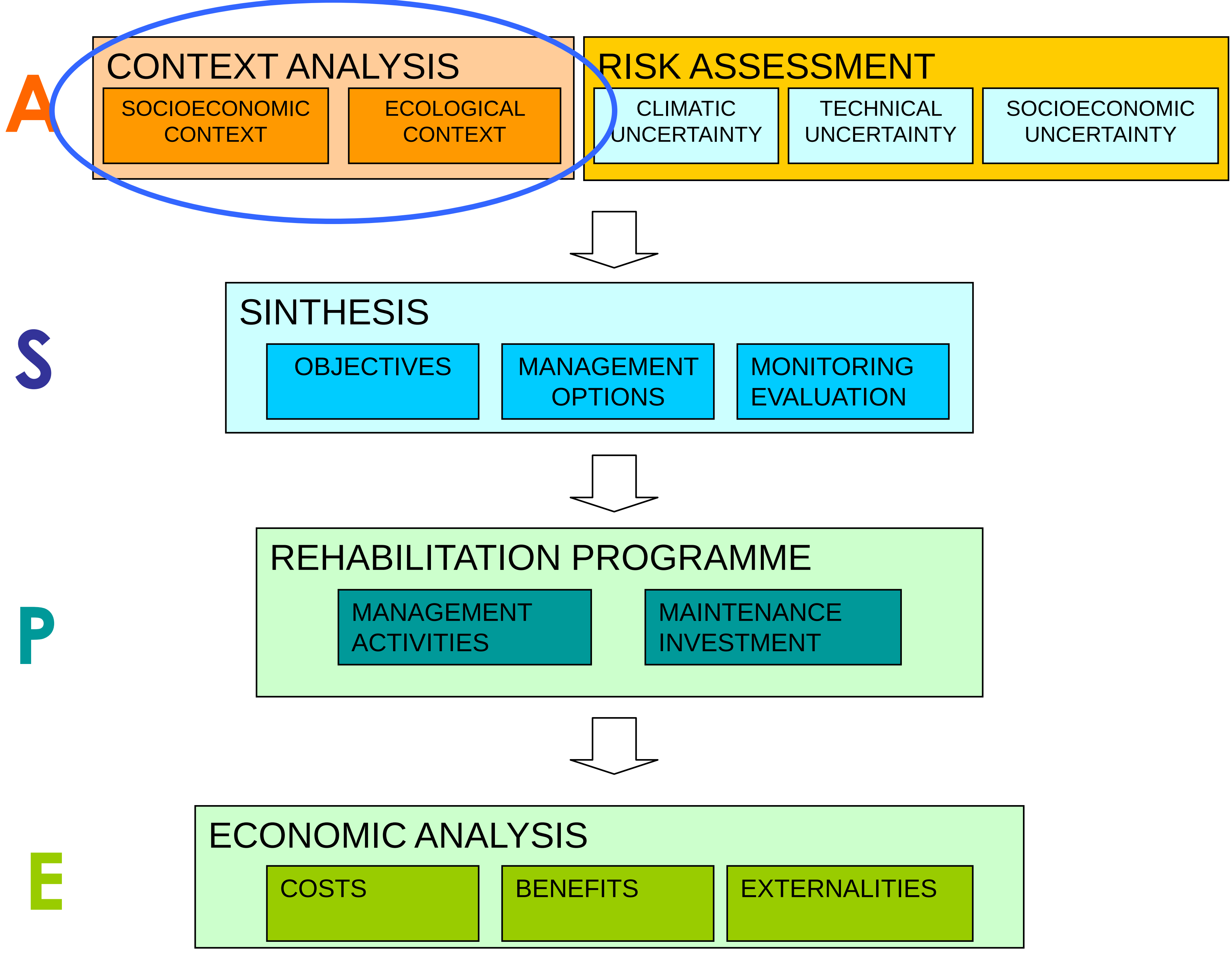
6. Planes, programas y presupuestos explícitos de las medidas físico-química-mecánica y vegetacionales

7. Un conjunto de estándares de desempeño para evaluar el proyecto

8. Protocolos de monitoreo para los estándares de desempeño

9. Procedimientos para mantención post-instalación y remediación

   Where feasible, at least one untreated control plot should be included at the project site, for purposes of comparison with the restored ecosystem.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Análisis del Contexto (Context Analysis)

Se refiere a las influencias espaciales sobre un sistema o la conexión espacial de un sitio con el paisaje que lo rodea

- Contexto Socioeconómico

  Considera aspectos económicos, estéticos, religiosos y de subsistencia

- Contexto Ecológico

  Considera aspectos de estructura y funcionamiento de los ecosistemas

Contexto Socioeconómico

e.g. presiones de poblaciones locales pueden tener efectos adversos en la rehabilitación, i.e. leña, pastoreo, vandalismo, incendios, etc.

Algunos aspectos relevantes:

- Tenencia de la tierra
- Demanda por bienes y servicios
- Densidad de la población
- Interés en el proyecto

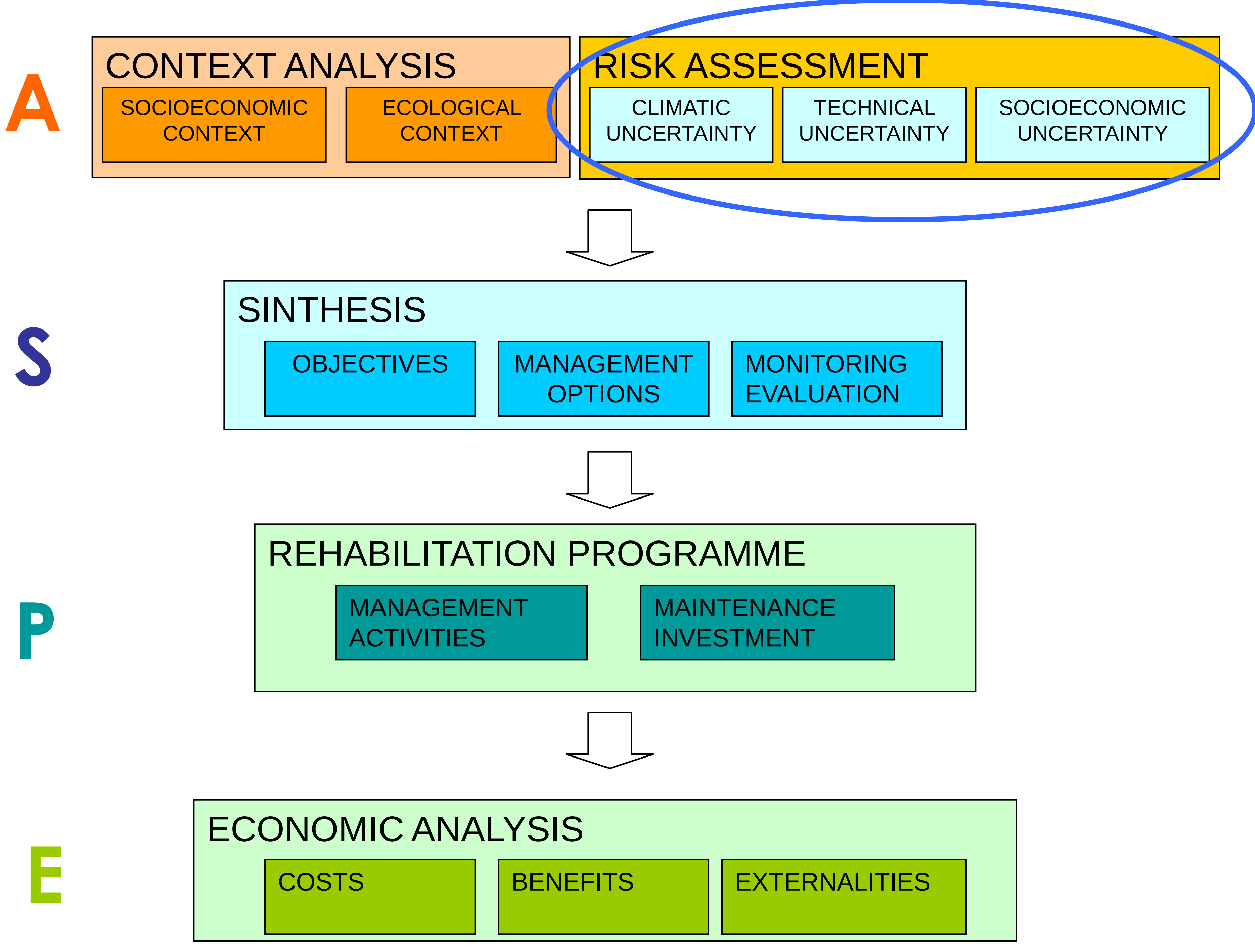
Contexto Ecológico

- Sitios degradados están insertos en paisajes dinámicos influyen en sitios a intervenir

- Sitios degradados tienen limitaciones inherentes e inducidas

- Este análisis debe considerar:

  - Ambiente abiótico
  - Ciclo de nutrientes
  - Ciclo del agua
  - Comunidades vegetales (procesos)
  - Interacciones entre distintos elementos del paisaje (movimientos de semillas y animales, flujos de energía y transporte de nutrientes a distintas partes del paisaje)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Riesgos e incertidumbre

- Análisis de riesgo requiere comprender las incertidumbres asociadas a los componentes del programa de rehabilitación
- Incertidumbre climática, socioeconómica y técnica
- Los impactos potenciales de éstas aumentan al aumentar:
  - El área
  - El tiempo
  - Tecnologías no probadas
  - Dependencia de comunidad
- Esto puede ser reducido con más conocimiento, más flexibilidad, y estímulos a la innovación

Incertidumbre Climática

No podemos cambiar el clima pero podemos tener mejor información para tomar decisiones

e.g. podemos conocer que tan frecuentes son eventos extremos, sequías, heladas, etc

Incertidumbre climática puede ser controlada:

- Usar muchas especies con amplio rango climático
- Preparación del sitio, alta calidad de plantas y plantación
- Estimular interacción microambiental positiva entre especies (e.g. sombra, semillación, etc)

Incertidumbre Técnica

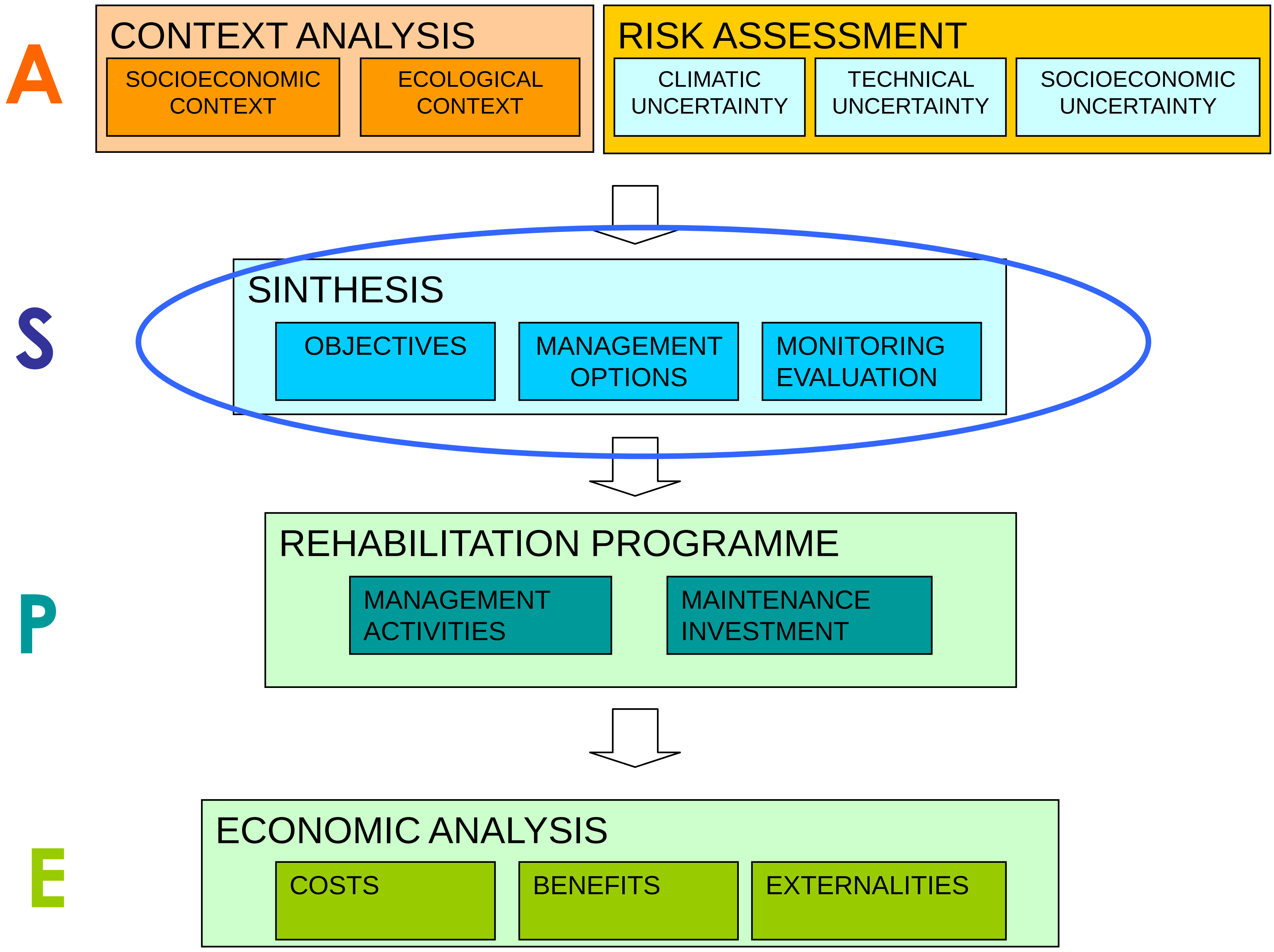
Incertidumbre asociada a nuevas tecnologías

Incertidumbre técnica puede ser controlada:

- No confiar en solo una tecnología
- Entrenamiento de personal y mantención
- Cuando hay poca información respecto de las especies, una mezcla de ellas reduce el riesgo
- Programas de monitoreo pueden constituir alarmas tempranas
- En proyectos de varios años, manejo adaptativo permitirá mejorar trabajo futuro basado en el pasado (requiere flexibilidad y monitoreo)

Incertidumbre Socioeconómica

- Las incertidumbres socioeconómicas son usualmente mayores que las técnicas
- Difícil predecir los cambios socioeconómicos
- E.g. Hay proyectos que dependen de la comunidad para llevarlos a cabo, a veces con trabajo voluntario, esto puede llegar a constituir un problema
- E.g. Nuevos caminos pueden permitir el acceso a un mayor número de personas a las áreas rehabilitadas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Monitoreo y Evaluación

- Monitoreo consiste en colección de información, evaluación y análisis para determinar nivel de éxito del proyecto
- Información puede ser cara de colectar, procesar y analizar
- Importante definir criterios mínimos para tomar buenas decisiones
- Monitoreo permite llevar a cabo manejo adaptativo

Sitios de Referencia

- Raramente se puede monitorear el duplicado exacto de un ecosistema
- Lo más común será tener alguna información histórica del sitio, o
- Información de un sitio similar al sitio a rehabilitar
- Ambas comparaciones con el sitio a rehabilitar son difíciles
- Lo más frecuente será evaluar el sitio antes y después de los tratamientos

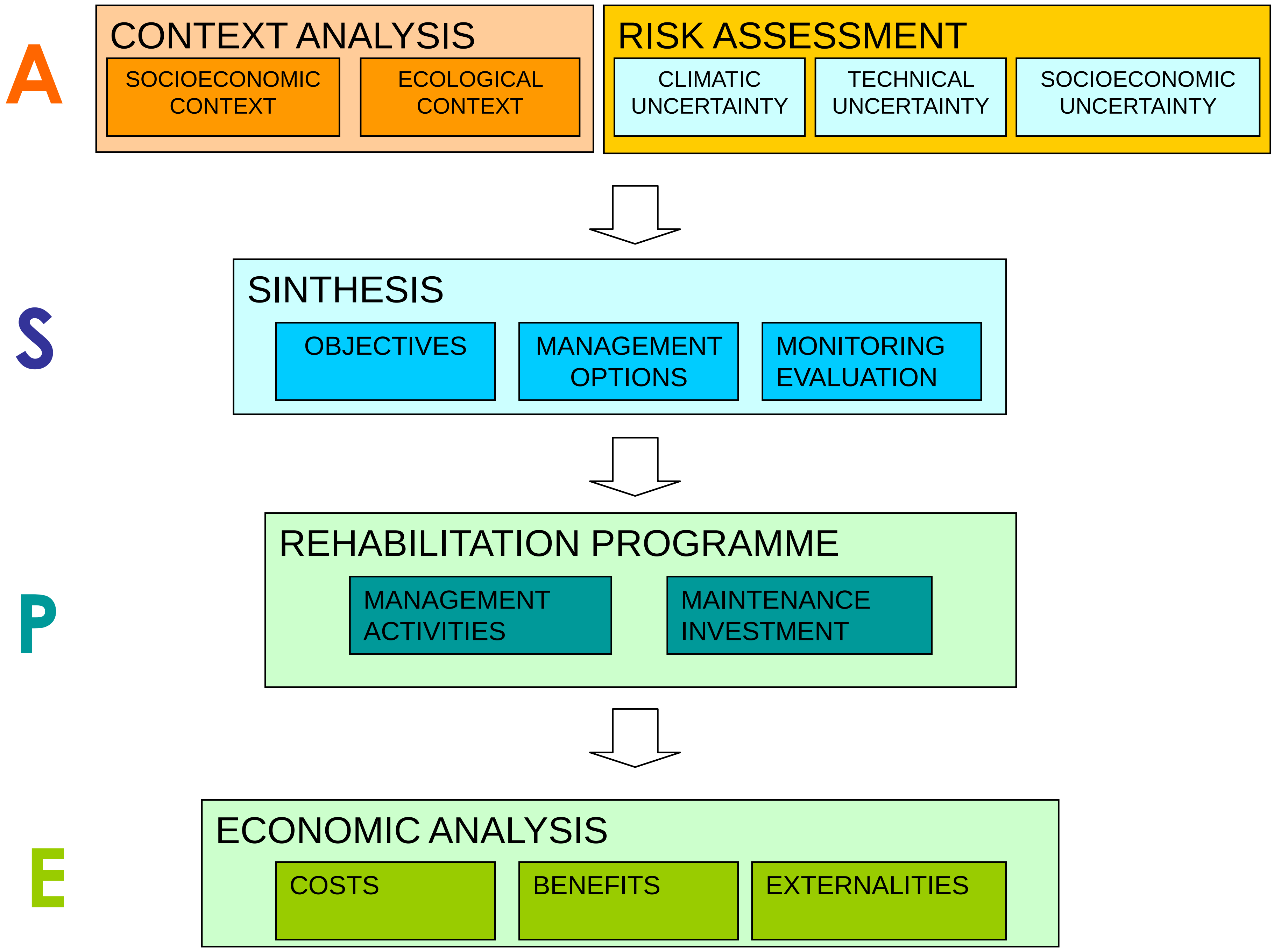
Sitios de Referencia

- Si fuera posible sería preferible localizar sitios que no estuvieran dañados o que estuvieran similarmente dañados

- El primero establece una meta y el segundo una medida desde que el proyecto comenzó

- Ambos proveen información respecto de los avances de la rehabilitación

- Enfatizar variables a medir que tengan que ver con los procesos limitantes e.g. ciclo del agua-> Infiltración, escorrentía, sedimentación, cobertura, etc.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ITEM	DESCRIPCIÓN	UNIDAD	CANTIDAD	PRECIO UNITARIO (US$)	TOTAL (US$)
		A. Reperfilado de Camino y Cuneta Lateral			
1	Excavación con maquinaria	m^3	3224	$2.5	$8,059
	Subtotal				**$8,059**
		B. Construcción de Terrazas			
2	Excavación con maquinaria	m^3	2550	$2.5	$6,376
	Subtotal				**$6,376**
		C. Barreras			
3	Mano de Obra	J	357	$25.0	$8,928
4	Materiales	m	3571	$18.7	$66,813
	Subtotal				**$75,742**

		E. Alcantarilla de Desagûe			
7	Mano de Obra	J	61	$25.0	$1,535
8	Materiales	m	614	$8.0	$4,942
	Subtotal				**$6,477**
		F. Diques Enrocados			
9	Mano de Obra	J	50	$25	$1,250
10	Materiales	unidades	10	$556	$5,555
	Subtotal				**$6,805**
		G. Diques Gaviones			
11	Mano de Obra	J	10	$25	$250
12	Materiales	unidades	2	$556	$1,111
	Subtotal				**$1,361**
		H. Diques Postes Largo 1.5m – Ancho 1.2m			
13	Mano de Obra	J	100	$25	$2,500
14	Materiales	unidades	20	$182	$3,647
	Subtotal				**$6,147**

			J. Plantación de Alta Montaña		
17	Excavación con maquinaria	casillas	7700	$0.83	$6,417
18	Establecimineto Plantación	plantas	7700	$0.80	$6,146
19	Riego	litros	154000	$0.19	$29,559
	Subtotal				**$42,121**
			K. Cercos		
20	Cercos	m	1226.4	$1.0030	$1,230
	Subtotal				**$1,230**
	SUBTOTAL				**$157,554**
	GASTOS GENERALES (20%)				**$31,511**
	TOTAL				**$189,064**

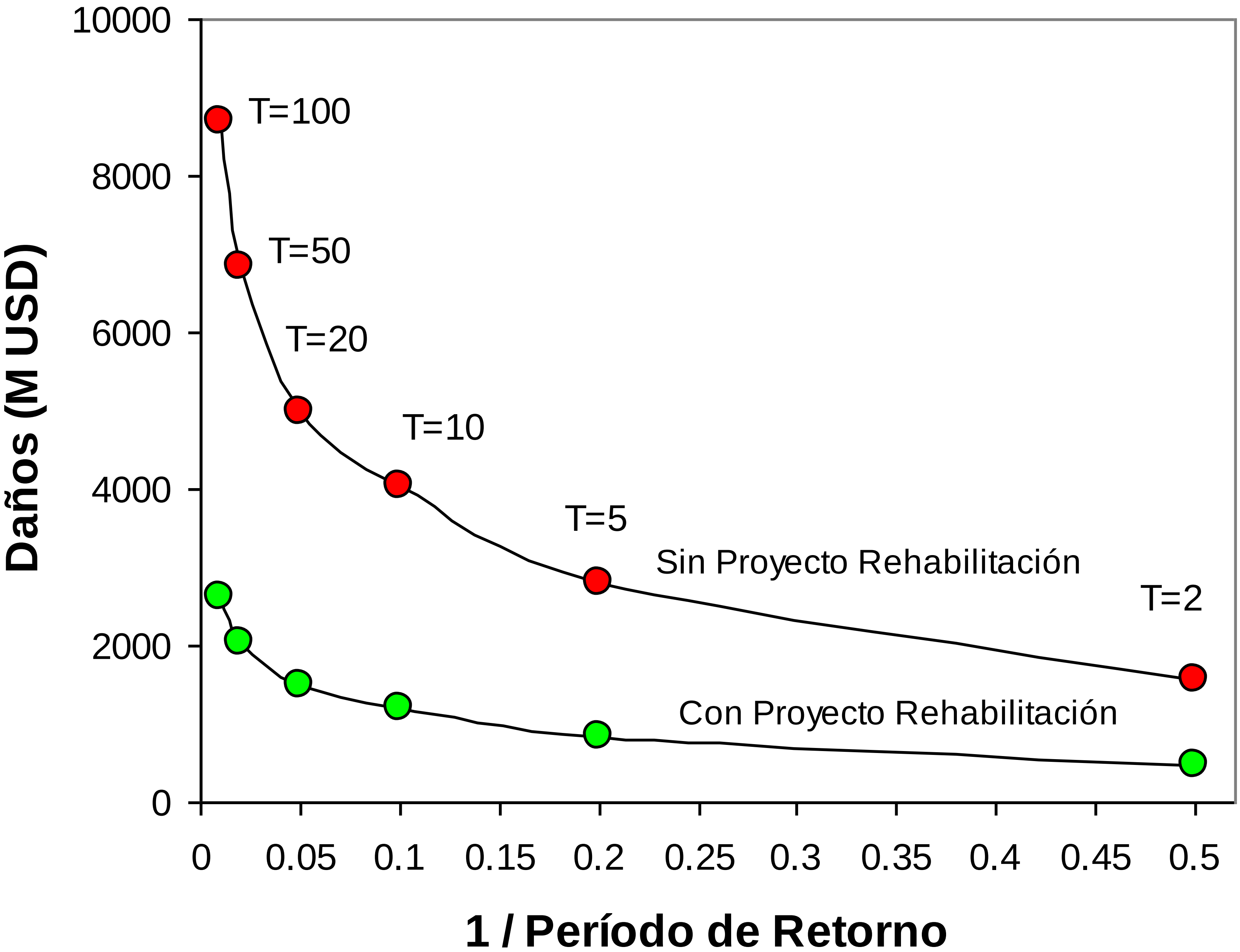


Figura 1. Daños totales con y sin proyecto para distintas probabilidades de ocurrencia (recíproco del período de retorno) para la microcuenca Traypin.

Estadístico	Periodo de Retorno								
	2 años			5 años			10 años		
	VPN (M US$)	TIR (%)	No Tormentas	VPN	TIR	No Tormentas	VPN	TIR	No Tormentas
min	867	20%	13.0	-227	-	0.0	-227	-	0.0
max	3957	62%	38.0	3763	86%	22.0	4303	101%	13.0
Promedio	2336	42%	25.6	1411	33%	9.1	1004	28%	4.7
Desv. St.	433	7%	3.5	602	11%	2.7	662	13%	2.1
n	10000	10000	10000	10000	9974	10000	10000	9744	10000

Estadístico	Periodo de Retorno								
	20 años			50 años			100 años		
	VPN (M US$)	TIR (%)	No Tormentas	VPN	TIR	No Tormentas	VPN	TIR	No Tormentas
min	-227	-	0.0	-227	-	0.0	-227	-	0.0
max	3935	122%	10.0	3347	109%	7.0	3083	144%	5.0
Promedio	558	23%	2.4	208	21%	1.0	56	22%	0.5
Desv. St.	604	13%	1.5	544	14%	1.0	484	16%	0.7
n	10000	8817	10000	10000	6030	10000	10000	3840	10000

Estadísticas básicas sobre 10 mil corridas para seis escenarios de tormentas con Periodos de retorno de 2, 5, 10, 20, 50 y 100 años del Proyecto de Rehabilitación Ambiental para la Microcuenca Traypin

Hog Island and Newton Creek

Ecological Restoration Master Plan • June 29, 2007

Specific Components of this Master Plan

A refined vision, goals and measurable objectives.
An ecological and cultural description of the sites designated for restoration.
Description and conceptual site plan illustrating ecological restoration initiatives consistent with the conservation goals in the St. Louis River Habitat Plan for the St. Louis River AOC.
Description and location of potential reference ecosystems along with information that will be used to develop a 'reference state.'
Description on how the proposed restoration initiatives will integrate with regional landscape processes (energy flows, nutrient cycling, wildlife movement, hydrologic flows and plant succession).
Regulatory permitting requirements.
An implementation strategy, phasing plan and a timeline of the restoration process, allowing sufficient time for self-generating ecological processes to resume.
Description of the ecological and institutional strategies that will be required for the long-term protection and management of the restored ecosystem.
A framework for performance standards, each with suitable monitoring protocols, by which the project can be evaluated within the trajectory selected as most desirable for its long-term ecological goals and objectives.
A framework for ensuring that stakeholders are involved in the continued development and management of the restoration initiatives.
Planning level cost estimates for final design, implementation, and management.

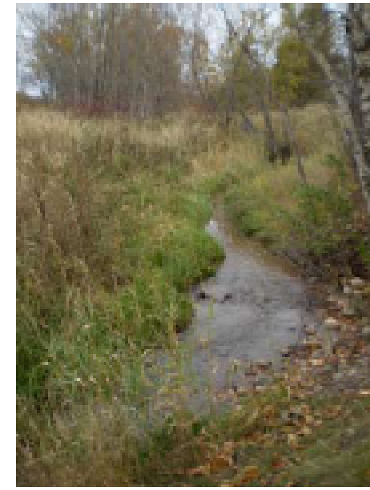
Executive Summary

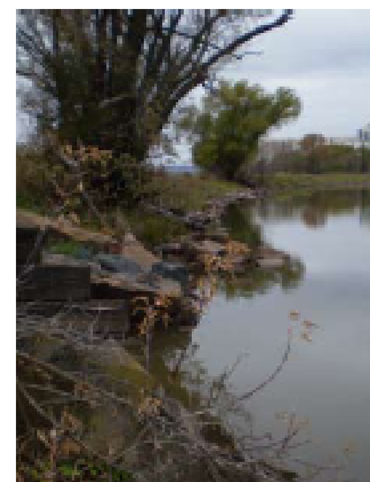
Foreword

1.0 The Hog Island and Newton Creek Master Plan

2.0 The Master Planning and Plan Development Process

3.0 Existing Conditions





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4.0 Ecological Restoration Sites

5.0 Ecological Restoration Plan

6.0 References

7.0 Appendices

1.2 Site History

The Lower St. Louis River estuary is known to have been settled by Lake Superior Chippewa Native American tribe. They lived in several small villages in the area including what is now the City of Superior. In the later 1600s, European contact and exploration of the area referred to the lower river as Fond du lac, which translated loosely into "Head" or "Foot of the Lake," or "where the water stops." The first European explorers were hunters and trappers, profiting from the fur trade. There is little evidence of the influence that Native American and early European inhabitants had on the regional landscape during this period, although there is an abundance of recent literature on the profound effect that other Native American tribes had on ecosystems through their use of natural resources, including hunting and fishing practices.

European trapping and trading, and later agriculture, came to the area. **In the 1800s as the fur trade declined commercial fishing for trout and whitefish grew. In 1854 the U.S. government signed a treaty with the local** Chippewa tribe that resulted in a population boom. By 1857, over 2,000 people lived in the City of Superior.

Construction of locks in 1855 allowed ships to move between Lakes Huron and Superior, giving access to the area's resources of iron ore, lumber, and grain which spurred the local onset of the industrial revolution. A railroad begun in 1861 and completed in 1870 spurred rapid growth in Duluth. The reconfiguration of the harbor shoreline began in 1872 with the cutting of a ship canal for Duluth through a baymouth sand bar. The River and Harbor Act passed by the federal government in 1873 included funds to dredge the harbor with additional work authorized in 1881. Superior began booming by 1886 with the establishment of grain elevators, flour mills, shipyards, and a coal and iron company. Official recognition of the City of Superior occurred in 1887 and by 1893 the population had reached 35,000 (by comparison, the population of Superior today is 27,180). A Congressional Act in 1896 joined the Duluth and Superior harbors under one administration, authorizing millions of dollars to enlarge the harbor and dredge channels to a depth of 20 feet.

Raw resources from logging and sawmills, rock and ore quarries, and Midwestern grain all benefited from and grew the nexus of rail and shipping that the cities of Duluth and Superior supported. Steel mills and oil companies developed in the early 1900' to meet the growing industrial needs of the region.

Shipping remains a key to the economies of Superior and Duluth, with the harbor ranking as the top Great Lakes port. Dredging and shoreline reconfiguration to support the ports completely redefined the natural area creating deep channels, docks, and fill land for industrial and residential development. New islands, such as Hog, Barker's, Interstate, and Hearding Islands were formed from the dredged material. Ultimately, shipping channels were dredged to depths of 27 feet.

Today, only a few natural elements remain from what was once a shallow freshwater estuary in the Lower St. Louis River **Harbor Area**. Allouez Bay is the only large, contiguous wetland complex remaining that represented a defining characteristic of the lower estuary. While many areas of the City of Superior are currently covered in scrub-shrub, forested, and emergent/wet meadow wetlands, the relatively less abundant unvegetated flats, open water, and aquatic bed wetland types around Hog Island speak to the significant potential of the project area as a restored and enhanced natural resource.

3.3 Ecological Conditions – Hog Island

Hog Island is a man-made feature. Beginning in the late 1800s, dredging operations within Superior Harbor to enlarge waterways for commercial shipping generated large amounts of fill material. During this period, the USACE disposed of this material by placing it in "open" areas of the Harbor and Allouez Bay. In the early part of the 20th century (in the 1920s to 1930s), Hog Island became a fill site, and an estimated 600,000 cubic yards of dredge material composed of sand and silt was deposited, forming an island roughly ½ mile long by ¼ mile wide. The origin of the name "Hog Island" is disputed, but some think that is because a hog farm was situated on it at one time, others think that the island is shaped like a hog (with the "snout" being the northern tip of the island).

Early historical photographs show an island that is disconnected from the mainland, but already remarkably vegetated (Figure ##). In contrast to the current conditions on the island, the 1951 Hog Island (Figure ##) had greater expanses of open grasslands in the interior, larger expanses of beach habitats on the eastern shoreline, and less emergent wetlands on the western shoreline. The "neck" of the island, connecting it to the mainland, likely developed as the natural result of emergent wetland growth and maturation in the inlet, and is formed from peat and sediments that accumulated during this process.

3.3.1 Hog Island Soils and Sediment Conditions

Hog Island was created utilizing dredge spoils from maintaining the shipping channel in Allouez Bay. The soils are composed primarily of lacustrine sand fill, and are assumed to have originated from the Superior Front Channel and or the Superior Harbor Basin. Surface soil samples (0-6 inches) analyzed from Hog Island verify a high sand textured soil and indicate a low organic matter content and low fertility. According to a study conducted by Johnson (2003), Hog Island dredged sediments had 3.0% organic matter while a particle size analysis found that greater than 95% of the sediment samples were comprised of sand with less than 5.0% consisting of clay. The pH was found to be low at 4.9. For comparison, Allouez dredged sediments analyzed for this study were also found to have a relatively low, acidic pH of 5.2.

Figure XX. Above, Hog Island in a 1951 aerial photograph. At left, a recent satellite image of Hog Island.

Table 4.1. The Lower St. Louis River Habitat Plan habitat types and reference ecosystem conditions

Habitat Type	Goals	Actions	Draft Criteria	Notes
Piping plover	Reestablish a breeding population of piping plover in the estuary.	Incorporate the results and recommendations from the USFWS for plover habitat restoration and recolonization	The establishment of one nesting pair of piping plover on Hog Island.	Remove vegetation from the sandy shoreline inland on the north side of the island and restrict human and small mammal access to the area
Industrially Influenced Bays	Avoid the loss of any open water and restore to habitat similar to the sheltered bays whenever possible.	Ensure a diversity of native emergent, floating leaved, and submerged aquatic vegetation as well as an increased diversity of native fish and bird species. Remediate contaminated sediments.	Compare to community types and species assemblages in adjacent Allouez Bay and Lower St. Louis River sheltered bays.	The Hog Island embayment is considered by some to be on a trajectory to more closely resemble the sheltered bay ecotype due to time and lack of disturbance.
Clay-Influenced Tributaries	The hydrology and related sediment loads within the respective watersheds should be managed to more closely resemble presettlement conditions. Ensure that native species continue to utilize this habitat at current or higher levels.	Restore instream habitat where degraded.	Improve physical, biological and chemical conditions to levels approaching clay-influenced tributary reference conditions.	Possible reference conditions for this ecotype are found in small Allouez Bay tributaries, Bear Creek and Bluff Creek.
Great Lakes Coastal Wetlands Complex	Protect, enhance, or restore wetland vegetation components.	Restore emergent and submergent marsh vegetation types.	Establish naturally regenerating wild rice and submerged aquatic vegetation (SAV) species within the embayment.	Seed sources for wild rice and SAV will require collection permits from state resource agencies and effective seed dispersal timing.
Upland Forest Communities	Maintain or enhance existing high quality remnants, and restore much or the remaining forested area to the composition and structure that would be expected if its ecological processes were operating within their natural range of variation.	Encourage native forest types along their existing restoration trajectory, promote desired forest ecotypes where applicable.	Assess existing forest ecotypes in the project areas and determine if they are comparable to recommendations made by Frelich (1999).	

4.2 Regional Ecological Reference Sites

Several areas adjacent to the project site contain ecosystem assemblages that provide suitable restoration "targets" identified by the Lower St. Louis River Habitat Plan, local resources managers, and Biohabitats field scientists during field reconnaissance efforts. The specific ecological reference data necessary to guide specific restoration actions has yet to be collected; including vegetative community type, distribution, and succession; the relative proportion of habitat complexes; fish and wildlife utilization; and specific hydrologic, soil, and topographic parameters.

4.2.1 Wisconsin Point

Wisconsin Point is the eastern portion of a long coastal barrier spit separating the waters of Lake Superior from Allouez Bay, a portion of the St.Louis River Estuary. Major site features include several miles of open sand beach and dunes, small interdunal wetlands, and a xeric forest of white and red pines, all of which may be utilized as near-field reference conditions for Hog Island ecological restoration planning. The point and adjacent Allouez Bay receive extensive visitation by migrating birds in the spring. Infrastructure includes roads, vehicle turnouts, a Coast Guard station, and breakwater.

A small, open interdunal swale near the western tip of the point supports a marsh community dominated by low graminoid plants, especially sedges and rushes. Several rare plants are present. The swale is surrounded by dense thickets of tall shrubs - mostly speckled alder, willows, and red-osier dogwood. These shrubs are encroaching on the openings and should be monitored and controlled if necessary. The shrubs do provide a measure of security for this fragile site by screening it from most passersby. During 1996 this swale was very wet, with standing water reaching a depth of over 30-cm in July and August.

Additionally, an area of Wisconsin Point to the east of the Coast Guard Station on the bay side of the point was cleared of vegetation and fenced to provide nesting habitat for piping plover. Another unique aspect of this particular habitat restoration effort was the excavation of the center of the sand area to a depth slightly below the water table to provide suitable colonization conditions for some rare interdunal swale plants (Epstein *et. al.*, 1997).

4.2.2 Allouez Bay

Allouez Bay is situated between the City of Superior's east-side neighborhood of Allouez and Wisconsin Point. The eastern end of the bay is shallow and contains a large marsh with patches of sedge meadow and a drowned tamarack swamp present near the base of Wisconsin Point. Several streams, Bear Creek, Bluff Creek and the Nemadji River empty into the bay. A portion of the wetland at the head of the bay, but now cut off by the access road to Wisconsin Point, was filled in the past.

The marsh is dominated by tall native graminoids, such as bur-reeds, bulrushes, spikerush, sedges, and cattails. Broad-leaved arrowhead is also among the dominant plants. Deep areas within and on the margins of the emergent marsh support floating-leaved and submergent aquatic macrophytes. The portions of the wetland nearest the shore are dominated by sedges. Tamarack snags are scattered throughout parts of this area.

It is possible that this wetland formerly contained extensive mats of wire-leaved sedges, but eutrophication, sedimentation, and other disturbances led to changed conditions which aided the spread and eventual dominance of the coarser, more nutrient tolerant emergents. Nevertheless, this wetland is composed mostly of native species, and plant diversity and wildlife values are quite high. In the early spring,

5.1 Restoration Goals / Objectives / and Actions

Goal A) Improve water and sediment quality conditions in Newton Creek and the Hog Island Inlet and reduce the threat of future contamination.

Objective A1) **Restore ecological flows in Newton Creek.**

- **Action 1:** Determine ecologically-optimal flow regime.
- **Action 2:** Work with Murphy Oil to determine release schedule feasible with plant operations.
- **Action 3:** Monitor to refine release schedule and establish in-stream and riparian habitat benefits.

Objective A2) **Stormwater management in upper watershed to limit nutrient and contaminant input into Newton Creek and Hog Island Inlet.**

- **Action 1:** Work with City of Superior to identify potential sources of pollution into Newton Creek, and develop recommendations for appropriate stormwater best management practices (BMPs) in the watershed.

Objective A3) **Reduce the threat of industrial contamination to water resources and sediments.**

- **Action 1:** Perform a risk assessment of industrial contamination in the project area. If warranted, construct additional emergency facilities to prevent spillage into Newton Creek.

Objective A4) **Use phytoremediation techniques where appropriate to reduce the toxicity of sediments not addressed by remediation efforts along the floodplain / riparian areas of Newton Creek and along the shoreline of Hog Island Inlet.**

- **Action 1:** Determine if contaminated sediments remain along the shoreline of Hog Island Inlet and along the Newton Creek floodplain terraces.
- **Action 2:** Establish a series of phytoremediation test plots and monitor for success.
- **Action 3:** Expand phytoremediation plots to other areas demonstrated to contain unacceptable levels of sediment contamination.

Goal B) Ecosystem conservation and protection for ecologically-sensitive habitat areas.

Objective B1) **Place remaining open areas into permanent protection through land acquisition or conservation easement.**

- **Action 1:** Work with the City of Superior and Douglas County to permanently protect remaining vacant public lands on Hog Island and within the Newton Creek watershed.

Objective B2) **Place privately-held open areas and sensitive habitats into permanent protection through land acquisition or conservation easement.**

- **Action 1:** Permanently protect privately-held upland and riparian habitats within the Newton Creek watershed.
- **Action 2:** Acquire / protect Ogdensburg Pier properties on the northwestern end of Hog Island Inlet.
- **Action 3:** Work with Burlington Northern Santa Fe railroad to acquire the railroad berms running parallel to the shoreline.

Goal C) Restore selected ecosystem components according to the restoration guiding principles.

Objective C1) **Eradicate selected invasive plant species.**

- **Action 1:** Perform a comprehensive invasive plant species inventory and mapping throughout ecologically sensitive areas.
- **Action 2:** Reed canary grass control.
- **Action 3:** Control of *Phragmites australis* along the Hog Island shoreline areas.
- **Action 4:** Actively monitor for migration of exotic invasive plants from the adjacent landscape, especially purple loosestrife.

Objective C2) **Enhance streamside and shoreline buffers for bird and wildlife habitat, and remove barriers to aquatic and terrestrial wildlife migration.**

- **Action 1:** Establish a 75 foot buffer along Newton Creek between 7th St and 2nd St.
- **Action 2:** Establish a 100 foot vegetative shoreline buffer around the perimeter of Hog Island Inlet.
- **Action 3:** Remove / retrofit culverts at road and sanitary sewer line crossings along Newton Creek.

Objective C3) **Restore / enhance wetland complexes along shallow water and shoreline areas.**

- **Action 1:** Restore sustainable, reproducing communities of wild rice along the Hog Island Inlet shoreline.
- **Action 2:** Expand areas of wetland vegetation into the northern and western areas of the inlet, along Superior shoreline and the Ogdensburg Pier.
- **Action 3:** Expand areas of wetland vegetation into the seiche-influenced areas of Newton Creek (between 2nd St. and the inlet).

Objective C4) **Restore / enhance habitat complexity in the open water areas of Hog Island Inlet.**

- **Action 1:** Use natural features such as logs and rocks to promote cover and nesting / roosting habitat for birds and additional fish and wildlife.
- **Action 2:** Restore populations of SAV.

Objective C5) **Enhance migratory bird habitats, especially for rare, threatened, endangered (RTE) species.**

- **Action 1:** Establish nesting habitats for piping plover on Hog Island beaches.

Objective C6) **Initiate post-project monitoring for any restoration actions that occur, and use information to inform other restoration actions as part of the AOC restoration program, and within the St. Louis River watershed.**

Goal D) In conjunction with restoration actions, create recreational, educational, and environmental stewardship activities for City of Superior and Douglas County residents.

Objective D1) **Create passive recreational opportunities compatible with sustainable ecosystem function.**

- Action 1: Extend existing trail system to include limited access to Newton Creek, Hog Island, and Hog Island Inlet.
- Action 2: Establish additional bird watching platforms on and around Hog Island and the inlet.
- Action 3: Create interpretative signage along trails and bird watching platforms as part of the proposed conservation and restoration projects to educate about different natural features of the site.

Objective D2) **Organize a Newton Creek / Hog Island local watershed group to coordinate volunteer and stewardship activities.**

- Action 1: Designate a body to direct public outreach efforts, and advocate for ecosystem restoration in the watershed.
- Action 2: Create an "adopt a stream" program in local schools. Contact local science teachers to add a segment about the site in science curricula.
- Action 3: Use the ecosystem restoration efforts at Hog Island and Newton Creek as a focus for student research projects at local universities such as Wisconsin Indianhead Technical College and University of Minnesota, Duluth, and **University of Wisconsin-Superior.**
- Action 4: Establish and maintain a Hog Island / Newton Creek project website.

5.3 Phasing of Restoration Actions

The restoration of Hog Island, Hog Island Inlet, and Newton C
occur in four distinct phases:

Phase 1 0-1 years from Master Plan adoption:

- Initiate ecological flow regime determination & feasibility assessment (
- Initiate risk assessment of industrial water contamination (A3:1);
- Initiate surveys and research to determine the extent of residual sedime contamination (A4:1);
- Initiate public and private property conservation and acquisition efforts (
- Initiate invasive species surveys and control efforts (C1:1, C1:2, C1:3);
- Initiate SAV restoration in Hog Island Inlet (C4:2).

Phase 2 2-4 years from Master Plan adoption:

- Implement ecological flows and begin monitoring (A1:2, A1:3);
- Initiate stormwater management in Newton Creek watershed (A2:1);
- Continue construction of additional industrial pollution control faciliti (A3:1);

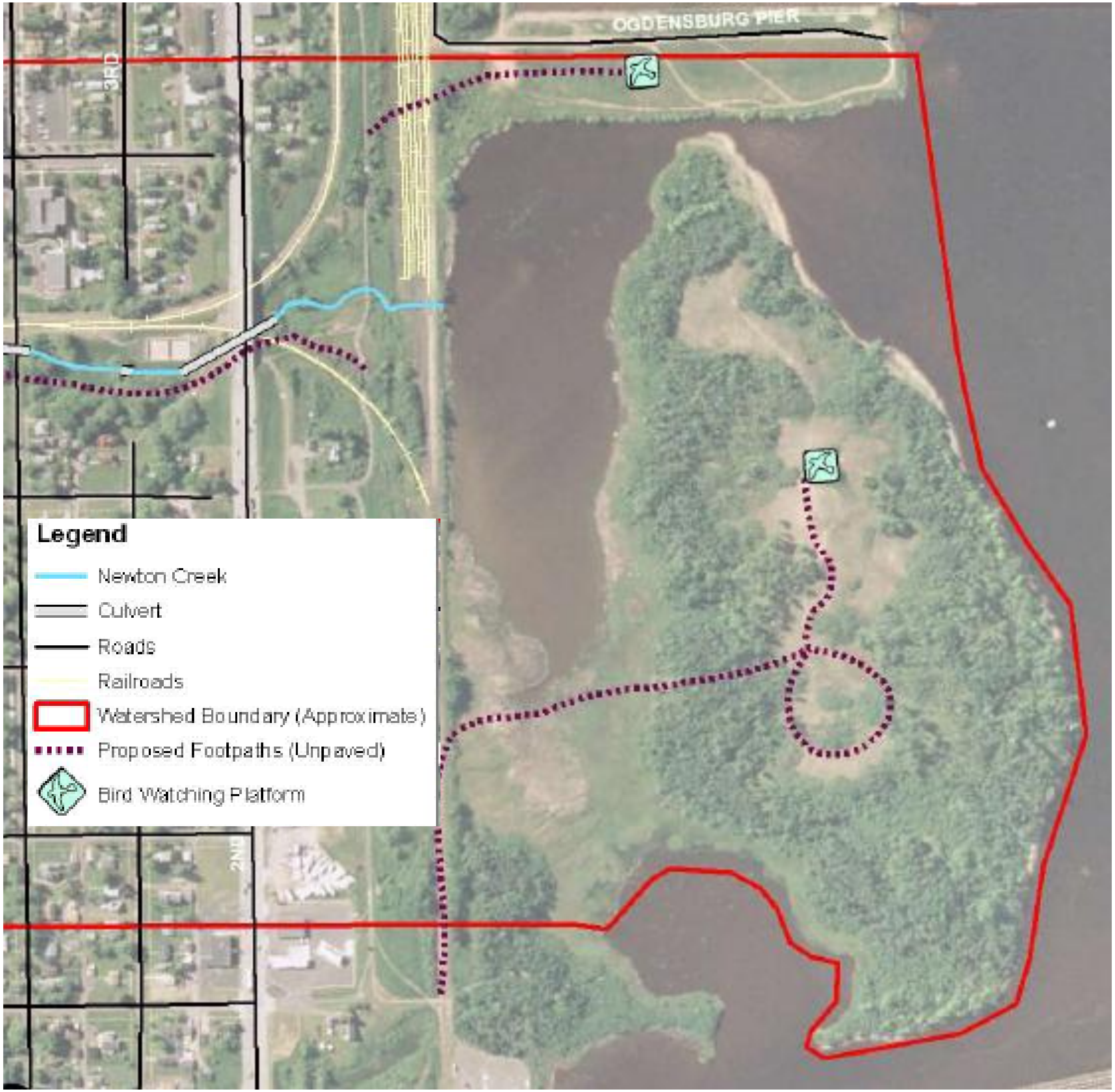
Action	0	1	2	3	4	5
Action A1:1 - Determine ecologically-optimal flow regime for Newton Creek.						
Action A1:2 - Determine release schedule compatible with plant operations.						
Action A1:3 - Monitor Newton Creek to refine release schedule and establish in-stream and riparian habitat benefits.						
Action A2:1 - Develop recommendations for appropriate stormwater best management practices (BMPs) in the watershed.						
Action A3:1 - Perform a risk assessment of industrial contamination in the project area.						
Action A4:1 - Determine if contaminated sediments remain along the shoreline of Hog Island inlet and along the Newton Creek floodplain terraces.						
Action A4:2 - Establish a series of phytoremediation test plots and monitor for success.						
Action A4:3 - Expand phytoremediation plots to other areas demonstrated to contain unacceptable levels of sediment contamination.						
Action B1:1 - Work with the City of Superior and Douglas County to permanently protect remaining vacant public lands on Hog Island and within the Newton Creek watershed.						
Action B2:1 - Permanently protect privately-held upland and riparian habitats within the Newton Creek watershed.						
Action B2:2 - Acquire / protect Ogdensburg Pier properties on the northwestern end of Hog Island inlet.						
Action B2:3 - Work with Burlington Northern Santa Fe railroad to acquire the railroad berms running parallel to the shoreline.						
Action C1:1 - Perform a comprehensive invasive plant species inventory and mapping throughout ecologically sensitive areas and control invasive vegetation.						
Action C1:2 – Control reed canary grass along Newton Creek						

5.4 Funding the Ecological Restoration Master Plan

Action	Size	Cost Estimate	$1,000	$5K
Action A1:1 - Determine ecologically-optimal flow regime for Newton Creek.	NA	$15,000 - $30,000		
Action A1:2 - Determine release schedule compatible with plant operations.	NA	??		
Action A1:3 - Monitor Newton Creek to refine release schedule and establish in-stream and riparian habitat benefits.	NA	$25,000 - $50,000		
Action A2:1 - Develop recommendations for appropriate stormwater best management practices (BMPs) in the watershed.	NA	$300,000 - $550,000		
Action A3:1 - Perform a risk assessment of industrial contamination in the project area.	NA	$250,000 - $575,000		
Action A4:1 - Determine if contaminated sediments remain along the shoreline of Hog Island inlet and along the Newton Creek floodplain terraces.	NA	$50,000 - $250,000		
Action A4:2 - Establish a series of phytoremediation test plots and monitor for success.		$70,000 - $80,000		
Action A4:3 - Expand phytoremediation plots to other areas demonstrated to contain unacceptable levels of sediment contamination.	??	??		
Action B1:1 - Work with the City of Superior and Douglas County to permanently protect remaining vacant public lands on Hog Island and within the Newton Creek watershed.	??	NA		
Action B2:1 - Permanently protect privately-held upland and riparian habitats within the Newton Creek watershed.	86.4 acres	$0 - $2,000,000+		
Action B2:2 - Acquire / protect Ogdensburg Pier properties on the northwestern end of Hog Island inlet.	9.7 acres	$485,000 - $970,000		
Action B2:3 - Work with Burlington Northern Santa Fe railroad to acquire the railroad berms running				

22ND
23RD
OGDENSBURG PIER
26TH
27TH
27TH
28TH
30TH
30TH
Legend
Roads
Railroads
Watershed Boundary (Approximate)
Sediment Contamination Survey
Phytoremediation Test Plots

OGDENSBURG PIER
Legend
Newton Creek
Culvert
Roads
Railroads
Watershed Boundary (Approximate)
Shoreline/Riparian Buffer Restoration
Culvert Removal/Retrofit
Feet
500
1,000
1,500
2,000


OGDENSBURG PIER
3RD
2ND
Legend
Newton Creek
Culvert
Roads
Railroads
Watershed Boundary (Approximate)
Proposed Footpaths (Unpaved)
Bird Watching Platform