Ecosystem Services and their Valuation

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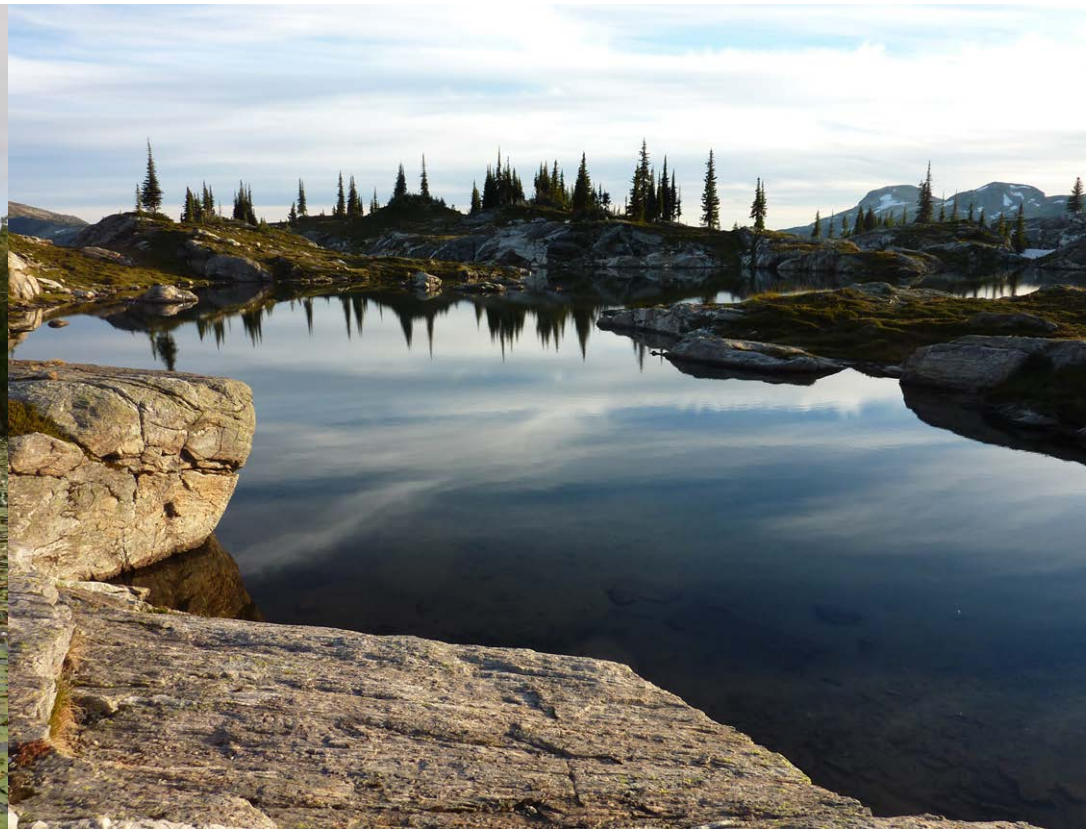
Healthy, functioning ecosystems are our ***natural capital*** and are essential for our quality of life & well-being…



…they provide services that we take for granted, because we get them for free.

Ecosystem Services: Definitions

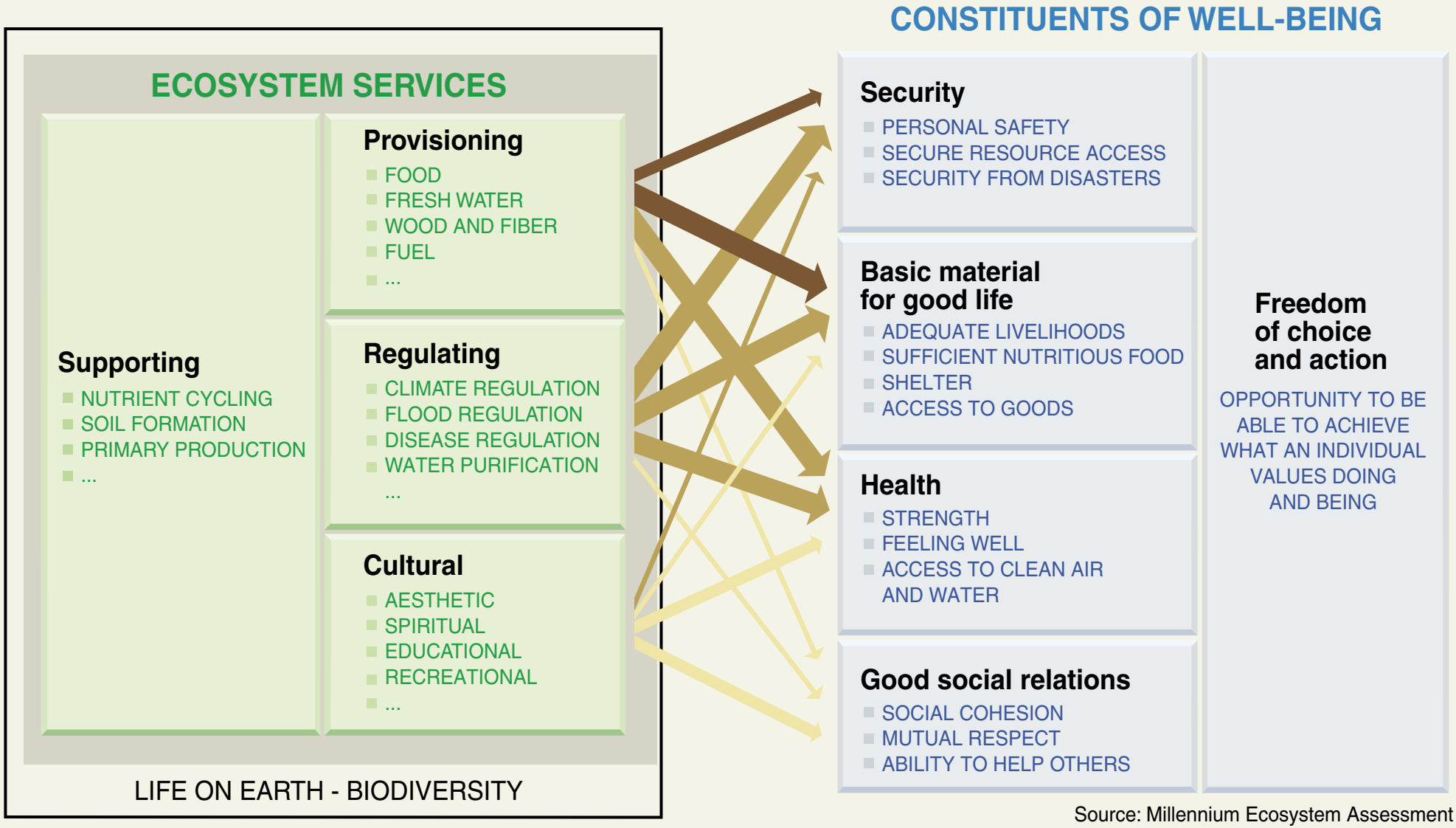
- "Ecosystem conditions and processes that support and sustain human life" (Millenium Ecosystem Assessment)
- Flows of value to human societies as a result of the state and quantity of natural capital (TEEB summary report)

Categories of Ecosystem Services
(Millenium Ecosystem Assessment)

- Provisioning services – e.g., timber, fish, wildlife (hunting), water, wild foods and medicinal plants (e.g., traditional uses), rangeland
- Regulating services – e.g., air quality regulation, climate regulation, waste treatment, water flow regulation, moderation of disturbances, pollination, erosion control, biological control;
- Cultural services – e.g., recreation, spiritual and aesthetic values, education & cognitive development, inspiration for art;
- Supporting services – e.g., nutrient cycling, habitats (e.g., spawning grounds), genepool protection

Human Well-being
(Millennium Ecosystem Assessment)

- basic material for a good life, such as secure and adequate livelihoods, enough food at all times, shelter, clothing, and access to goods
- health, including feeling well and having a healthy physical environment, such as clean air and access to clean water
- good social relations, including social cohesion, mutual respect, and the ability to help others and provide for children
- security, including secure access to natural and other resources, personal safety, and security from natural and human-made disasters
- freedom of choice and action



Source: Millennium Ecosystem Assessment

ARROW'S COLOR
Potential for mediation by socioeconomic factors

- Low
- Medium
- High

ARROW'S WIDTH
Intensity of linkages between ecosystem services and human well-being

- Weak
- Medium
- Strong

The Problem

- All indicators suggest that we are living beyond Earth's natural biocapacity and thus eroding our natural capital, and ecosystem's ability to provide us with ecosystem services, threatening the ability of humans to live healthy and fulfilled lives

Natural capital depreciation as % of adjusted net national income

(Data source: World Bank)

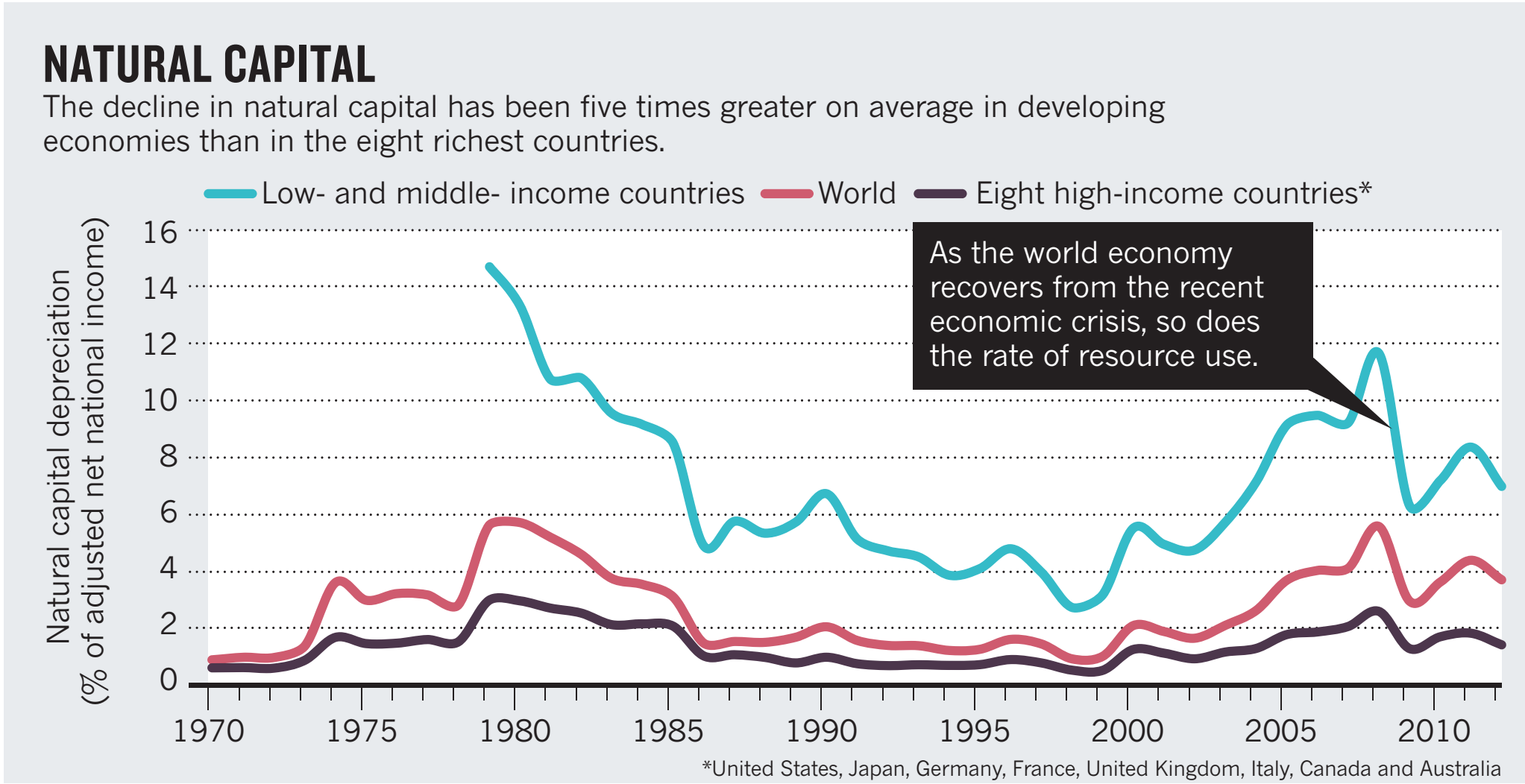
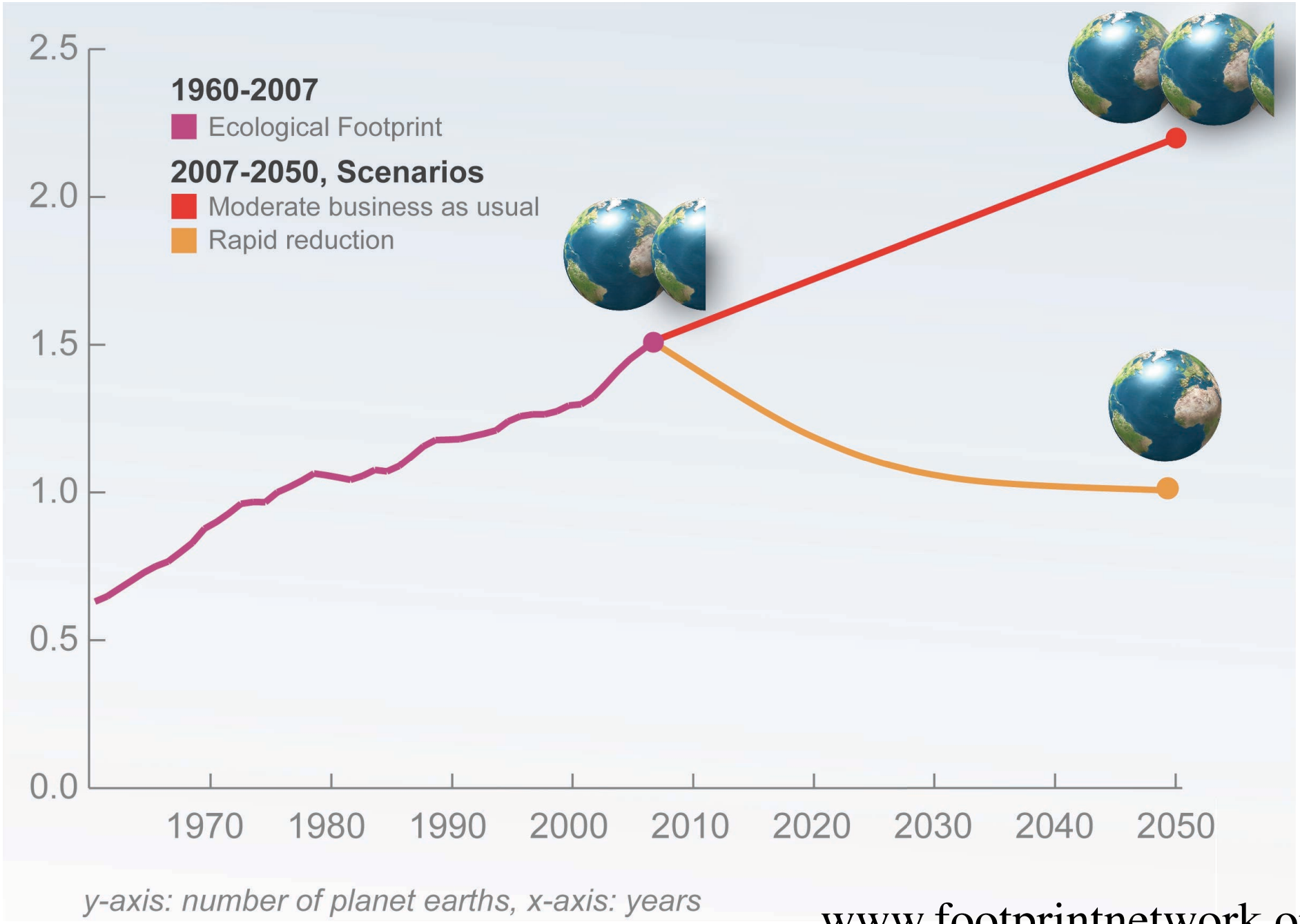


Figure reproduced from Barbier, 2014, *Nature*

Global ecological footprint



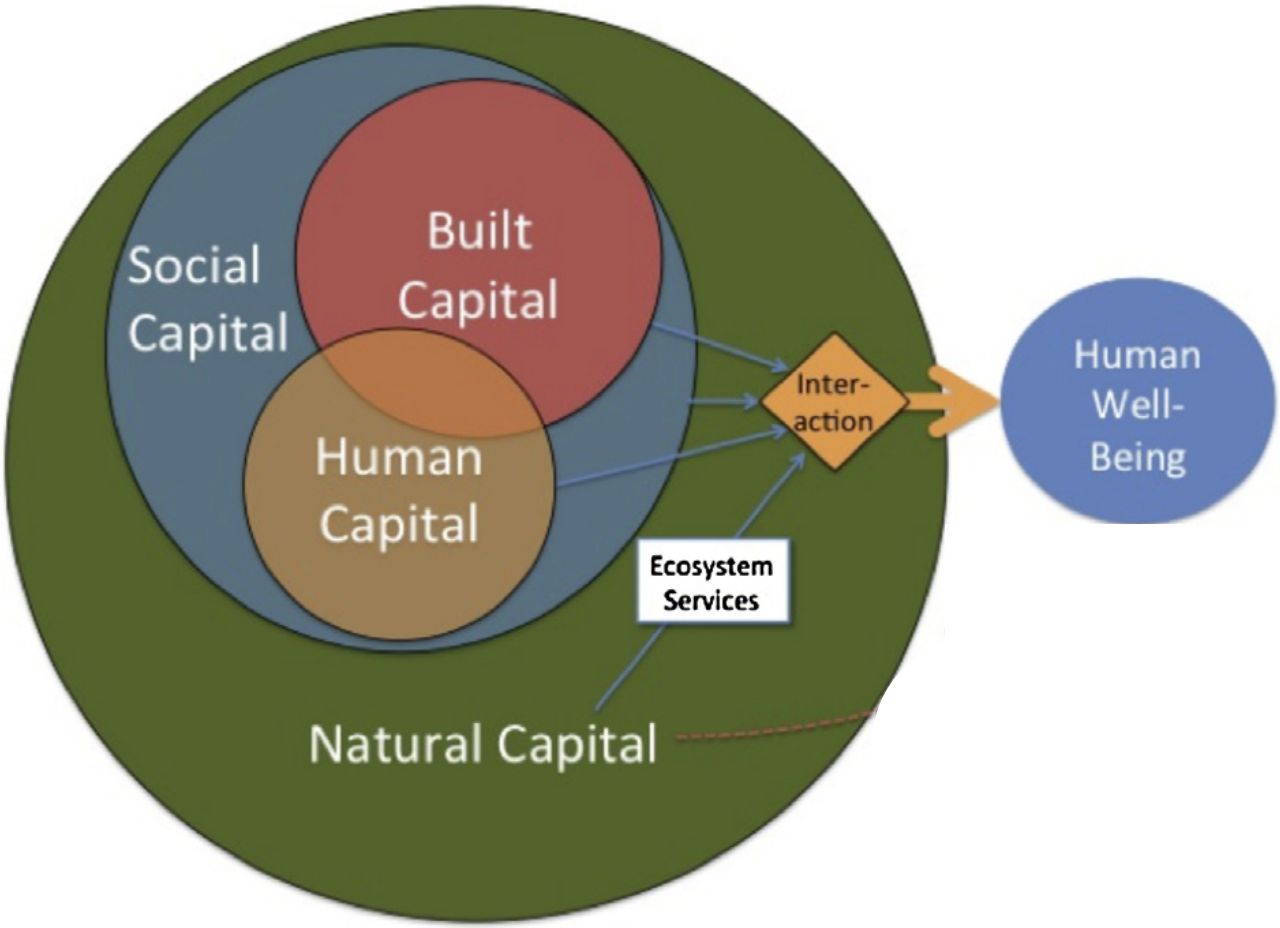
www.footprintnetwork.org

Economic Valuation of Ecosystem Services - A solution?

Valuing nature:
The ecological economics approach

- Introduces the concept of ***natural capital***, to which we can attach a monetary value
- Attempt to internalize environmental externalities into the current economic system
- Based on the premise that unsustainable use of natural resources occurs due to market signals that make it logical and profitable to do so and that the failure to account for the full economic values of ecosystems and biodiversity has been a significant factor in their continuing loss and degradation

The concept of natural capital



Source: Constanza et al. 2014

Valuing nature: Methods

- For many provisioning ecosystem services (e.g., timber) there is a well defined market value that can be used
- For services with non-market values, a variety of methods are employed…

Valuing nature: Methods

Table 15: Non-Market Ecosystem Valuation Techniques[127]

Avoided Cost (AC): Ecosystem services allow society to avoid costs that would have been incurred in the absence of those services. For example, flood control provided by a barrier island reduces property damage along the coast.
Replacement Cost (RC): Services could be replaced with human-made systems. For example, nutrient cycling waste treatment can be replaced with costly treatment systems.
Net Factor Income (NFI): Services provide for the enhancement of incomes. For example, water-quality improvements increase commercial fisheries catches and incomes from the fishery.
Travel Cost (TC): Service demand may require travel, the cost of which can reflect the implied value of the service. For example, recreation areas attract distant visitors whose value placed on that area must be at least what they were willing to pay to travel to it.
Hedonic Pricing (HP): Service demand may be reflected in the prices people will pay for associated goods. This method is often used to estimate property values. For example, housing prices along the coastline tend to exceed the prices of inland homes.
Contingent Valuation (CV): Service demand may be elicited by posing hypothetical scenarios in surveys that involve some valuation of land-use alternatives. This method is often used for less tangible services like wildlife habitat or biodiversity. For example, people would be willing to pay for increased preservation of beaches and shoreline.

Source: Wilson, 2008

Valuing nature:
The ecological economics approach

- A meta-analysis of hundreds of case studies for ecosystems around the world, suggests that the *ecosystem services provided by the biosphere* are estimated at $125 trillion per year (Constanza et al., 2014)

Case studies

The Good News

- Many ecosystem services are consumed regionally, by people living in the landscape that provides those services
- There is thus the opportunity to act locally and achieve measurable benefits at regional and global scales

Case study: Ontario Greenbelt

The *Greenbelt Act, 2005* enabled the creation of a Greenbelt Plan to protect about 1.8 million acres of environmentally sensitive and agricultural land around Greater Toronto

Source: Wilson, 2008, *Ontario's wealth, Canada's future*. Report prepared for the David Suzuki Foundation.

Case study: Ontario Greenbelt

Figure 4: Forest Land Cover in the Greenbelt

Source: Wilson, 2008, *Ontario's wealth, Canada's future*. Report prepared for the David Suzuki Foundation.

Case study: Ontario Greenbelt

Table 5: Summary Table of the Greenbelt's Forests Ecosystem Values

ECOSYSTEM SERVICE FUNCTIONS	VALUE $/HA/YEAR	TOTAL $MILLIONS
Air Quality	$377.14	$68.9
Climate regulation (carbon stored)	$919	$167.9
Climate regulation (annual carbon uptake)	$39.11	$7.1
Water runoff control	$1,523	$278.1
Water filtration	$473.98	$86.5
Erosion control and sediment retention	n/a	n/a
Soil formation	$17	$3.2
Nutrient cycling	n/a	n/a
Waste treatment	$58	$10.6
Pollination (agri)	$1,109	$202.5
Pollination (trees)	$537	$98.0
Biological control	$25.97	$4.7
Habitat/Refugia	n/a	n/a
Genetic resources	n/a	n/a
Recreation & Aesthetics	$334.73	$61.1
Cultural/Spiritual	n/a	n/a
Total forest area (ha) 182,594		
Total C$(2005)	$5,414	$988.6

Source: Wilson, 2008, *Ontario's wealth, Canada's future*. Report prepared for the David Suzuki Foundation.

Case study: Ontario Greenbelt

Table 9: The Value of Ecosystem Services provided by the Greenbelt's Farmlands

ECOSYSTEM SERVICES	CROPLAND $/HA/YEAR	IDLE LAND $/HA/YEAR	HEDGEROWS $/HA/YEAR	ORCHARDS $/HA/YEAR	TOTAL $MILLIONS
Climate regulation (stored carbon in soils)	$333	$317	$328	$298	$156.7
Climate regulation (annual carbon uptake)		$29	$29	$29	$2.6
Erosion control and sediment retention		$6	$6	$6	$0.5
Soil formation	$6	$6	$6		$2.8
Nutrient cycling		$24	$24	$24	$2.1
Habitat for Pollination for Crop Production		$1,109	$1,109		$95.3
Biological Control		$40	$40		$3.4
Cultural value	$138	$138	$138	$138	$65.7
Total $/ha/yr	$477	$1,667	$1,678	$494	
Area (ha)	384,378	78,889	7,039	5,202	475,508
Total value $M/yr	$183	$132	$12	$3	$329

Source: Wilson, 2008, *Ontario's wealth, Canada's future*. Report prepared for the David Suzuki Foundation.

Case study: Ontario Greenbelt

Table 10: Total Value of Greenbelt's Ecosystem Services by Ecosystem Service

ECOSYSTEM SERVICE	TOTAL VALUE
Air quality	$68,868,821
Climate regulation (stored carbon)	$366,451,342
Climate regulation (annual carbon uptake)	$10,982,151
Flood control (wetlands)	$379,676,010
Water regulation (control of runoff – forests)	$278,103,520
Water filtration	$131,107,489
Erosion control and sediment retention	$532,417
Soil formation	$6,005,164
Nutrient cycling	$2,141,547
Waste treatment	$294,360,279
Pollination (agriculture)	$298,235,257
Natural regeneration	$98,001,705
Biological control	$8,175,746
Habitat/Refugia	$548,184,172
Genetic resources	n/a
Recreation and aesthetics	$95,207,535
Cultural/Spiritual (agriculture)	$65,674,796
Total value ($/year)	$2,651,707,951

Source: Wilson, 2008, *Ontario's wealth, Canada's future*. Report prepared for the David Suzuki Foundation.

Case study: Ontario Greenbelt

- Current situation: Provincial Government Green Belt Plan, 2016 updates in consultation
  - Includes language referring to the value of ecosystem services provided by the Green Belt esp. for human health & well-being and for climate change mitigation

Case study: Maury Island, WA

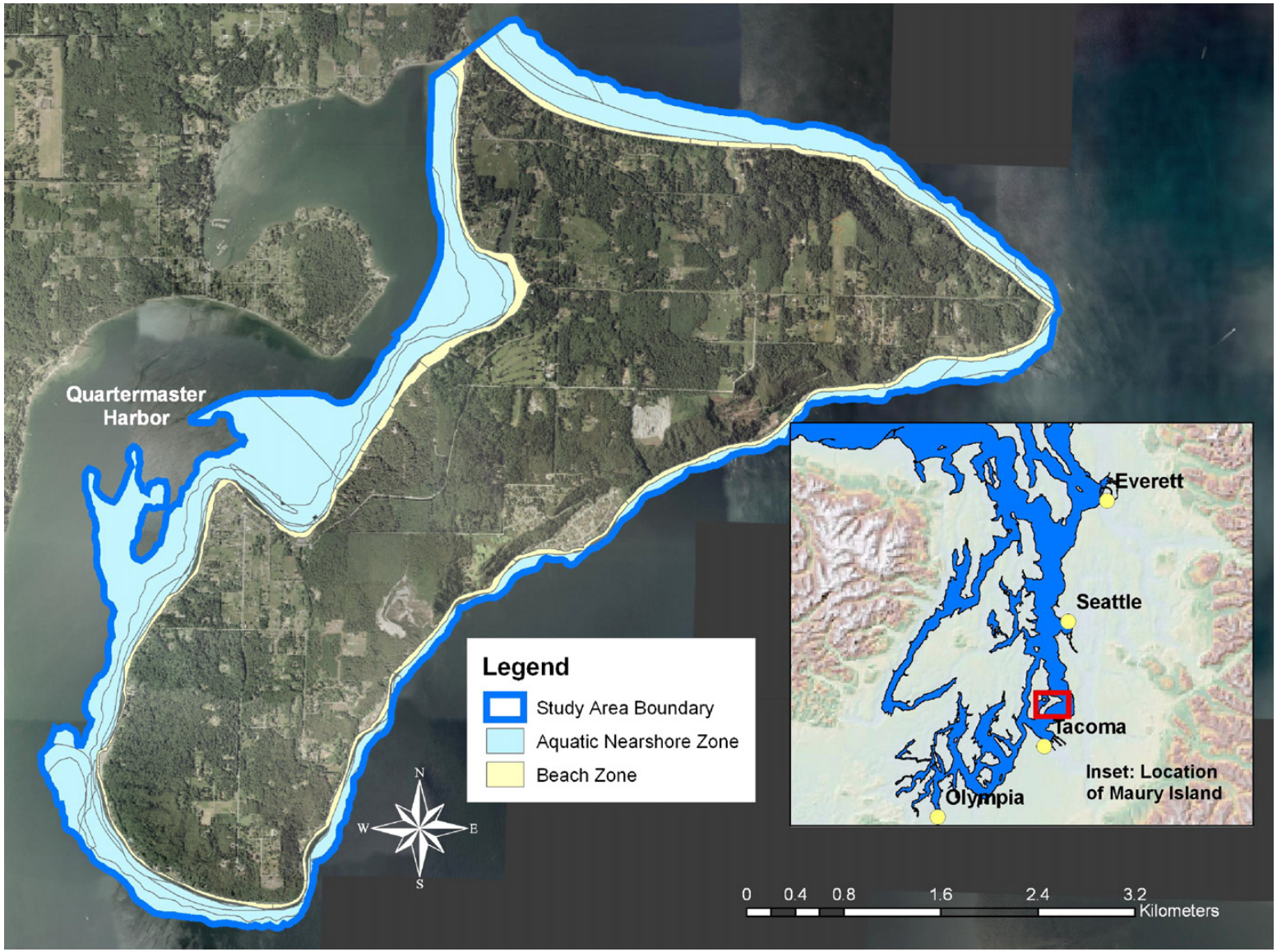


Fig. 1 – Map of Maury Island study area.

Source: Troy and Wilson, 2006, *Ecological Economics*

Case study: Maury Island, WA

Table 5 – Ecosystem service values by land cover and service type for Maury Island

Land cover	Aesthetic and amenity	Climate and atmospheric regulation	Disturbance prevention	Food and raw materials	Habitat refugium	Recreation	Soil retention and formation	Waste assimilation	Water regulation and supply
Beach	$ –	$ –	$ –	$ –	$ –	$2,371,006	$ –	$ –	$ –
Beach near dwelling	$4,442,228	$ –	$ –	$ –	$ –	$ –	$3,133,597	$ –	$ –
Coastal riparian	$ 224,009	$ –	$ 48,622	$ –	$ 509,067	$ 10,732	$ 107,842	$ 29,872	$314,520
Forest	$ 7703	$1,391,576	$ –	$ –	$ 10,041	$ 483,395	$ –	$ –	$ 13,695
Freshwater stream	$ 25	$ –	$ –	$ –	$ 24,641	$ 17,585	$ –	$ –	$ 23,807
Freshwater wetland	$ 17,866	$ –	$ 56,893	$ –	$ 85,466	$ 4203	$ –	$104,642	$ 20
Grassland/ herbaceous	$ –	$ 2649	$ –	$ –	$ –	$ 755	$ 379	$ 32,915	$ 1135
Nearshore habitat	$ –	$ –	$ –	$2,080,557	$3,518,838	$3,605,238	$ –	$ –	$ –
Saltwater wetland	$ –	$ –	$ 3770	$ –	$ –	$ 173	$ –	$ 1,474	$ 4110
Column total	$ 4,691,832	$1,394,224	$ 109,284	$2,080,557	$4,148,054	$6,493,088	$ 3,241,818	$168,903	$357,286

Source: Troy and Wilson, 2006, *Ecological Economics*

Case study: Maury Island, WA

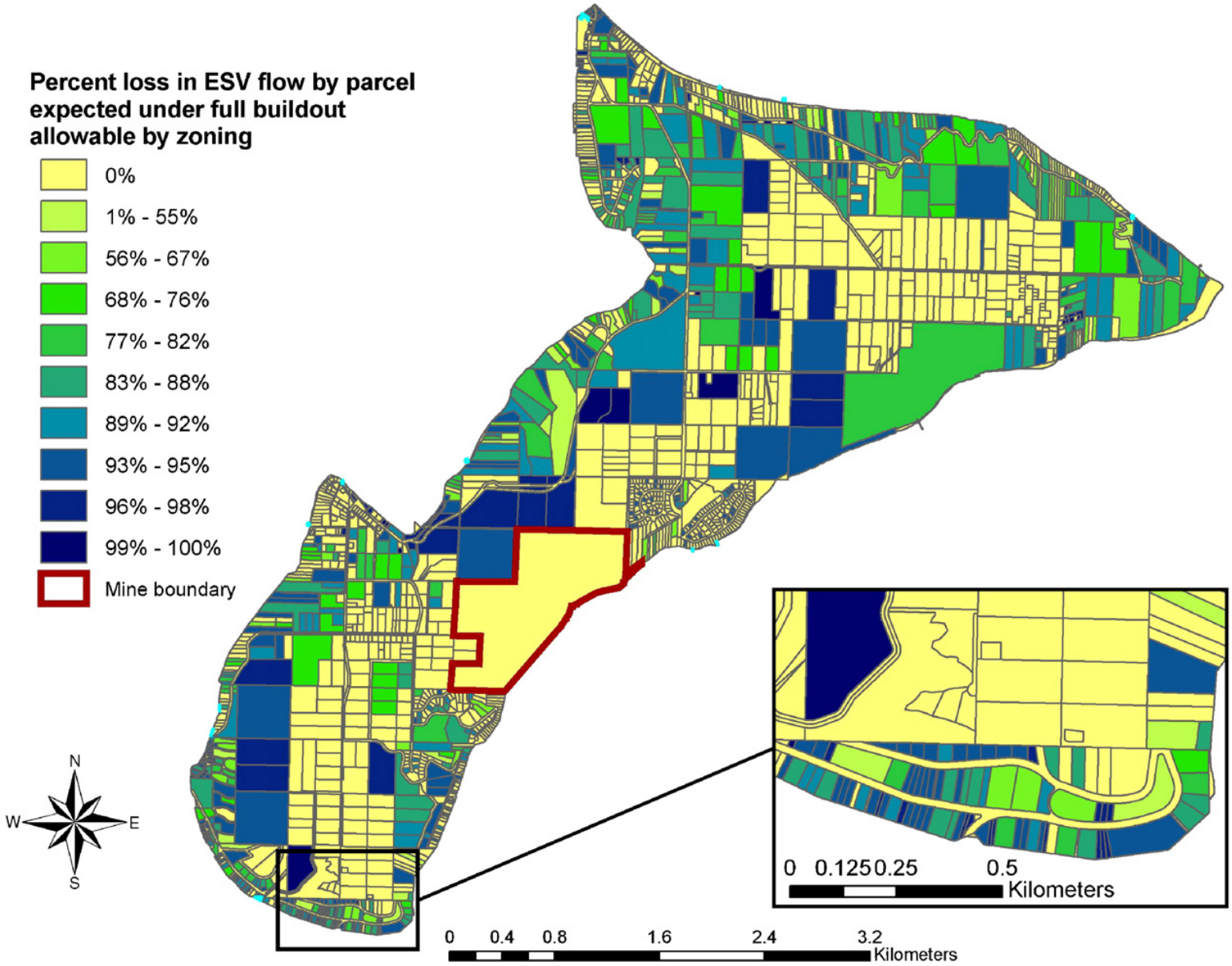
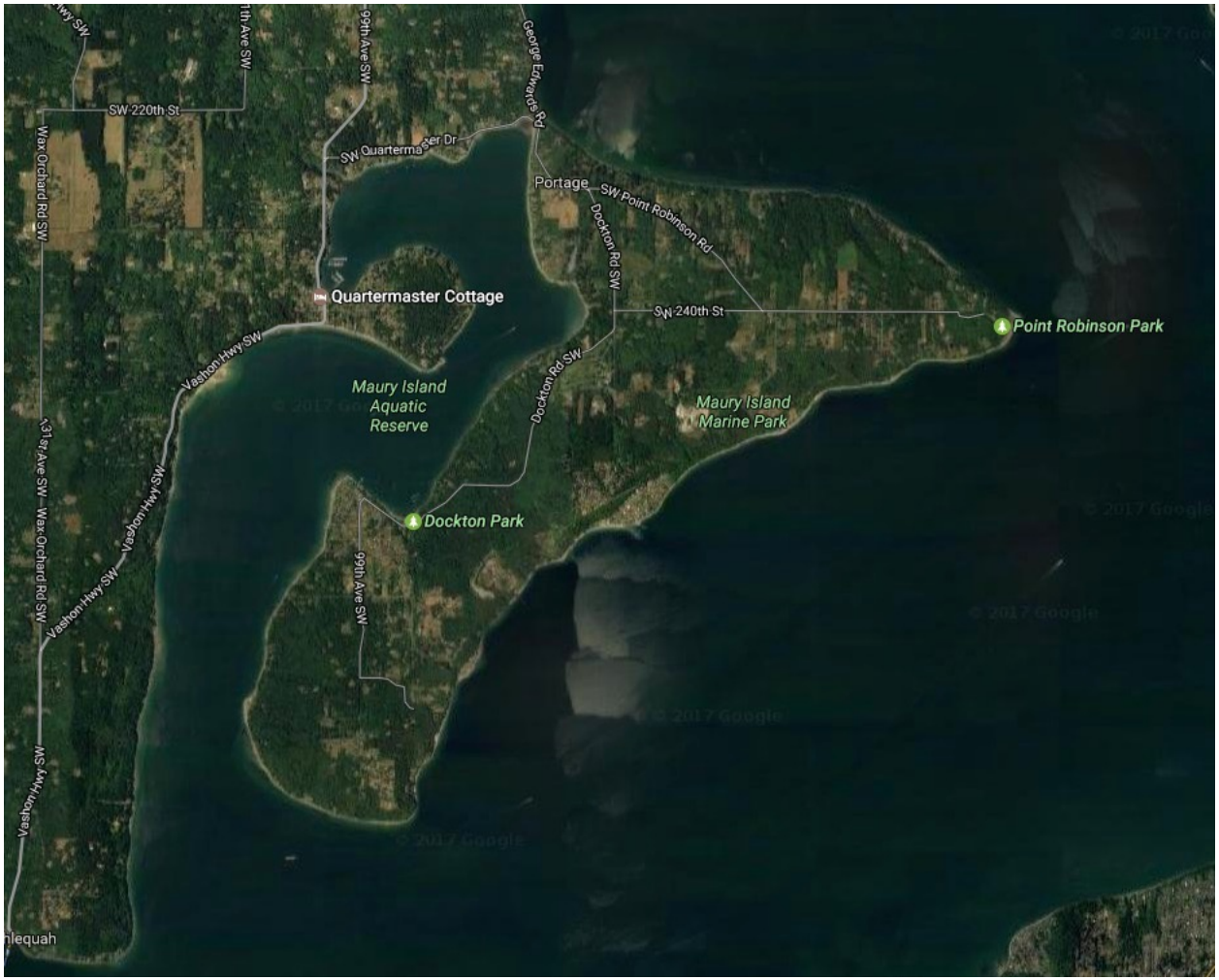


Fig. 5 – Estimated percentage reduction in yearly ecosystem service value flows between current conditions and full zoning buildout conditions by parcel for Maury Island in 2004 dollars.

Source: Troy and Wilson, 2006, *Ecological Economics*

Case study: Maury Island, WA



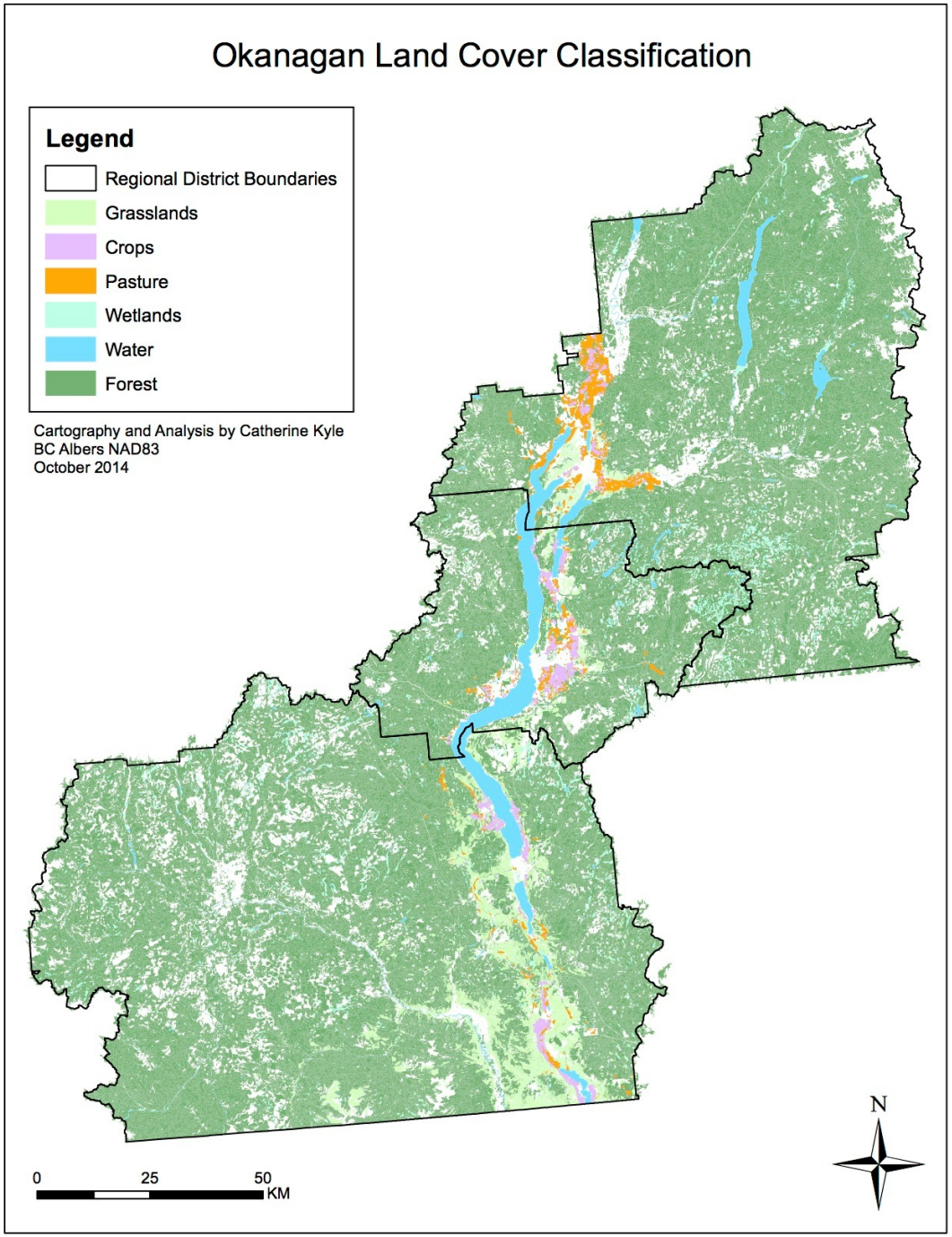
Google imagery 2017

Outcome:

No build out

Creation of a Marine Park and aquatic reserve around the island

Ecosystem Services Mapping for the Okanagan



The value of natural capital in the Okanagan

Based on global average values for different land cover types, ecosystem services provided by the Okanagan landscape are valued at a minimum of ***$6.7 billion/year***

(calculations by L. Parrott)

Table 1: Land cover areas in the Okanagan and values of ecosystem service flows.

Land cover	Area (hectares)	Unit values ($2007/ha/yr)*	Total value ($2007/yr)
Crops	7820	$5,567	$43,535,610
Pasture	15520	$4,166	$64,654,904
Water	64108	$12,512	$802,121,298
Wetlands	12219	$25,681	$313,792,030
Forest	1629744	$3,137	$5,112,507,587
Grasslands	90626	$4,166	$377,549,249
Total			**$6,714,160,678**

http://complexity.ok.ubc.ca/2014/10/30/the-value-of-natural-capital-in-the-okanagan/

Ongoing Work

- Mapping of present and historical (pre- and post-European settlement) ecosystem service provisioning for the entire Okanagan landscape using indicators available from existing BC datasets (Environment Canada Ecosystem Partnerships program funding)
- Maps will be used to identify areas of ES hotspots, and to measure relative change in ES over time

Summary

Summary

- Human health and well-being, as well as our local economies, are intricately linked to the ecosystem services provided by the landscapes in which we live
- Ecosystem services continue to be eroded due to short term planning and economic incentives that fail to account for depreciation of natural capital

Summary

- Accounting for the value (monetary or non-monetary) of ecosystem services can lead to more sustainable regional development and better quality human lives

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