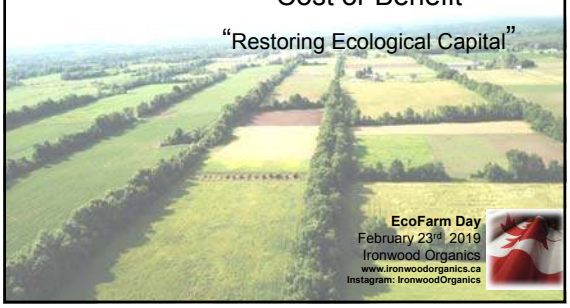
Growing Ecosystem Services

Cost or Benefit

"Restoring Ecological Capital"



EcoFarm Day
February 23rd 2019
Ironwood Organics
www.ironwoodorganics.ca
Instagram: IronwoodOrganics

Context of the planet

- Distance to moon 363,000 km
- Thickness of lithosphere 150 km to mantle
- Thickness of atmosphere 60 km
- Average depth of ocean 3.7 km
- Thickness of soil .5 m
- Thickness of rhizosphere 2mm

(Where our world interacts with the rest of the world)
(Dirt is what we are made of, Soil is how we were made)

2

Ecosystem Processes

- climate regulation
- heat redistribution
- natural hazard regulation
- water purification
- waste management
- pollination or pest control.
- N,C,P cycles

3

Ecosystem Services We Can "Grow"

- Provided for "free" but has value
- Assumes environment is intact
- Compounding benefits such as lower cost of production
- Better quality food
- Cleaner air
- Better water quality and retention
- Lower health care costs
- Lower insurance costs
- Better quality of life

WHO: Millennium Ecosystem Assessment Synthesis Report

4

Ecosystem Balance Sheet

- Is the farm better or worse each growing season?
- Compounding benefits
- Compounding detriments
- Benefits generally not added as part of GDP
- Loss of that services value is not subtracted from GDP (in fact they are added)

5

Innovation without understanding

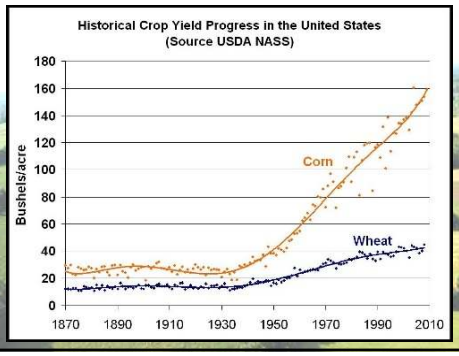
- "It took humans roughly 50,000 years to deplete the planet's large land mammals
- 5000 years to exhaust most of the planet's coastal environments
- 500 years to impoverish the open ocean
- and about 5 years to run through the creatures of the deep"

Boris Worm - Dalhousie

- Not exactly sustainable activity
- The **planet is finite**, as is its ability to sustain life

6

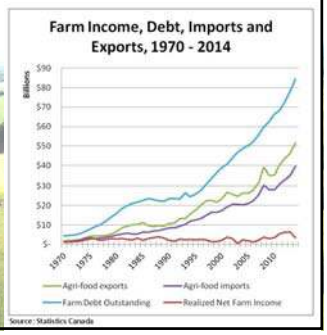
Old vs. new



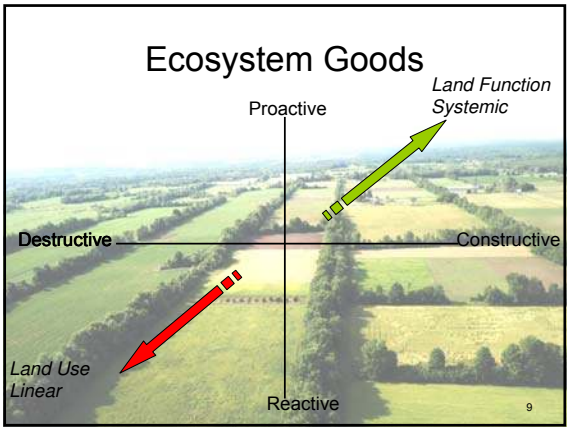
7

Yields Rise With Debt

- Financial debts
- Moving resources around (import/export)
- No mention of ecological goods and services



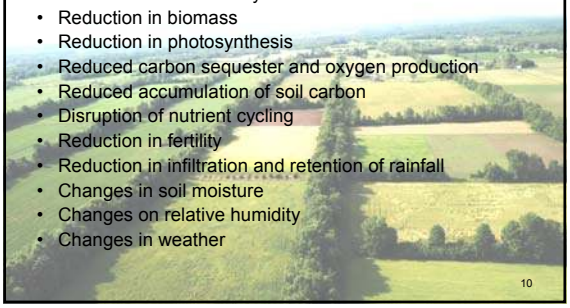
Ecosystem Goods



9

Diversity going down

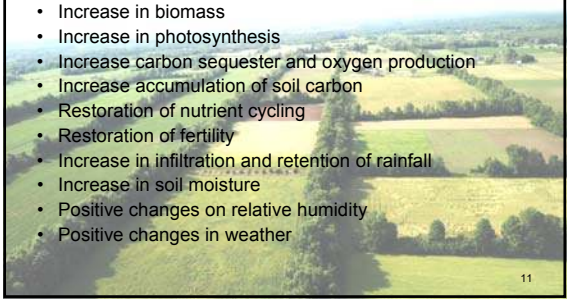
- Reduction in biodiversity
- Reduction in biomass
- Reduction in photosynthesis
- Reduced carbon sequester and oxygen production
- Reduced accumulation of soil carbon
- Disruption of nutrient cycling
- Reduction in fertility
- Reduction in infiltration and retention of rainfall
- Changes in soil moisture
- Changes on relative humidity
- Changes in weather



10

Diversity going up

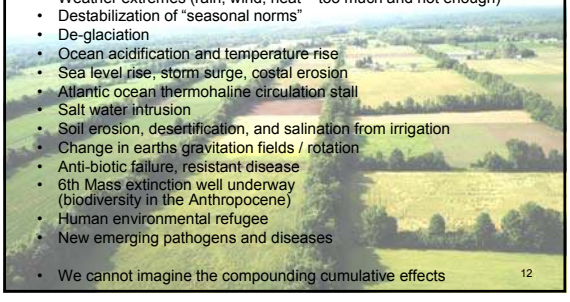
- Increase in biodiversity
- Increase in biomass
- Increase in photosynthesis
- Increase carbon sequester and oxygen production
- Increase accumulation of soil carbon
- Restoration of nutrient cycling
- Restoration of fertility
- Increase in infiltration and retention of rainfall
- Increase in soil moisture
- Positive changes on relative humidity
- Positive changes in weather



11

Approaching Storm Clouds

- Climatic change and warming
- Weather extremes (rain, wind, heat – too much and not enough)
- Destabilization of “seasonal norms”
- De-glaciation
- Ocean acidification and temperature rise
- Sea level rise, storm surge, costal erosion
- Atlantic ocean thermohaline circulation stall
- Salt water intrusion
- Soil erosion, desertification, and salination from irrigation
- Change in earths gravitation fields / rotation
- Anti-biotic failure, resistant disease
- 6th Mass extinction well underway (biodiversity in the Anthropocene)
- Human environmental refugee
- New emerging pathogens and diseases
- We cannot imagine the compounding cumulative effects



12

Our role on the farm

- Diversity is what we should be growing
- Diversity leads to stability
- Stability leads to resiliency
- Resiliency leads to sustainability
- Sustainability leads to prosperity/survival
- Sustainability relies on ecological capital

- Diversity is based on “the goods”

13

Wolves and Tropic Cascade

- 250,000 reduced to less than 500 by 1970
- 1973 listed with the EPA
- Yellowstone wolf introduction resulted in a massive tropic cascade.
- Direct and indirect consequences
- Wolves kept the Elk on the move
- Overgrazing reduced – soil erosion reduced
- The willow recovered followed by riparian areas
- Beaver moved back in with restored food source and building material
- Spring run off slowed and aquifer recharged .
- Fish rebounded
- Song birds returned in the thickets and help spread wild flower seed

14

On Farm Goods & Services

Initiatives that mitigate effects of climate change and lead to diversity….

1. Trees and hedgerows
2. Growing soil (organic matter & biome)
3. Pest management through biodiversity
4. Seed saving / landrace genetics

15

Hedgerows

- Over 6 linear km
- 90% deciduous
- Most nut producing
- Continuous inter-planting
- Species for the future
- Avoid disease susceptible species
- Focus on species with tap roots for strength and water
- Revenue trees (wood, fruit, nuts)

- 30' buffer on 15 acres "costs" 1.5 acre in area and @140' in perimeter

16

Hedgerow services

- Reduces heat/cool cycles
- Keeps soil moist for biology/crops
- Stable soil inoculants source
- Sequesters deep carbon
- Permaculture (nuts and berries)
- Early flowers for pollinators
- Home heating (new carbon)
- Habitat for biodiversity
- Farm tourism opportunities

17

Hedgerow functions

- Provide habitat for biodiversity
  - Birds eat insects, insects eat other insects etc
  - Pollen source for pollinators
  - Roosts for bats, nests for song birds
- Mechanically slows extreme wind
  - Reduces evaporation and transpiration
  - Reduces grain lodging
  - Reduces soil erosion
- Traps snow
  - Insulated soil, replenish aquifers
  - Traps everyone else's blowing dirt
  - Mitigates against spring flash thaw/freeze
  - Slows spring thaw
  - Protects winter cereals, garlic, tulips etc

18

Ecotone: The edge effect

- Consider a 6 acre field with dimension 1000' x 264'
- 25' perimeter buffer results in a perimeter that is 82% and area that is 77% (4.62 acres)
- Resulting buffer area is 1.6 acres
- Yield loss occurs ½ height of hedgerow out
- Average yield gain of 7% - 15% to 10 x tree height
- Annual impact vs. long term impact

19

Winds

- Driven by temperature differences
- Physical effects on crops and hedgerows
- Environmental effects (moisture)
- Structural effects of farm building and infrastructure.
- Building codes obsolete

21

Insurance

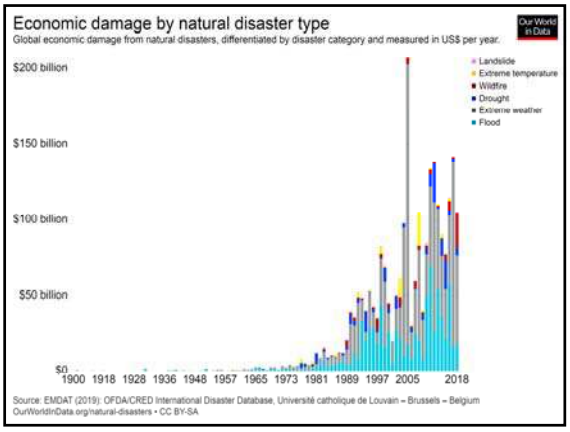
- Insurance claims costs are passed on
- IAG says climate change could make world 'uninsurable': Financial Review, Nov 2018
- Risk avoidance reduces financial risk

22

Table 6.2. Extreme event, location, and economic impact for the United States. Source: NCDC, 2011.

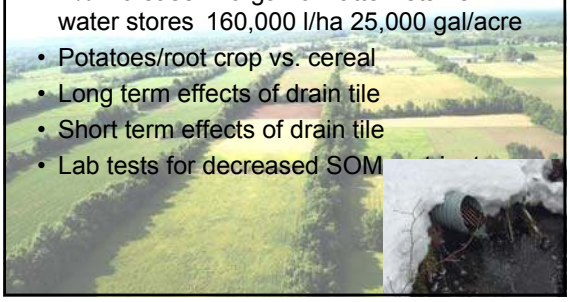
Year	Event	Location	Sector	Economic Impact (2011 $)
2011	Upper Missouri River Flooding	Upper Midwest (MT,ND,SD, IA, KS, MO)	Agriculture	2.0 Billion
2011	Mississippi River Flooding	Lower Mississippi River (AR, TN, LA, MS, MO)	Agriculture	1.9 Billion (3-4 Billion total)
2011	Heat/Drought	Southern Plains/Southwest	Agriculture	10.0 Billion
2009	Drought	Southwest/Great Plains (TX, OK, KS, AZ, NM, CA)	Agriculture	5.3 Billion
2008	Drought	South and West (CA, TX, GA, TN, NC, SC)	Agriculture	2.0 Billion
2008	Flooding	Upper Midwest (IA, IL, IN, MO, MN, NE, WI)	Agriculture	15.8 Billion Total
2007	Drought	Great Plains and Eastern U.S.	Agriculture	5.5 Billion
2007	Freeze	East and Midwest U.S.	Agriculture	2.2 Billion
2007	Freeze	California	Agriculture	1.5 Billion
2006	Drought	Central U.S.	Agriculture	6.7 Billion
2005	Drought	Central US (AR,IL,IN, MO, OH,WI)	Agriculture	1.2 Billion
2003	Storms and Hail	Southern Plains and lower MS valley	Agriculture	1.6 Billion
2002	Drought	30 states, western, Great Plains, and eastern U.S.	Agriculture	12.5 Billion
2000	Heat/Drought	South-Central and Southeastern U.S.	Agriculture	5.2 Billion
1999	Heat/Drought	Eastern U.S.	Agriculture	1.4 Billion
1998	Freeze	California	Agriculture	3.5 Billion
1998	Heat/Drought	TX/OK to the Carolinas	Agriculture	8.3-12.4 Billion
1995-1996	Drought	TX/OK	Agriculture	7.2 Billion
1993	Flooding	Upper Midwest	All Sectors	32.8 Billion

23



Water too much and not enough

- 1% increase in organic matter retains water stores 160,000 l/ha 25,000 gal/acre
- Potatoes/root crop vs. cereal
- Long term effects of drain tile
- Short term effects of drain tile
- Lab tests for decreased SOM



Soil is what we really farm

- If it's not in the soil, it's not in our food.
  (This is true of the good and the bad)

- Structural rehabilitation
- Reduce soil pans
- Increase organic matter
- Increase soil organisms (number and abundance)
- Reduce erosion

- Retain existing – build new – increase health

28

Soil and Soil Organism Services

- Reduce compaction
- Nutrient cycling: vertically and horizontally
- ph modulation
- Increase water retention
- Reduce water “evacuation”
- Increase aquifer recharge
- Temperature fluctuation dampening
- Reduced pans increase root depth

29

Rhizobia

Glomalin

- Sticky glycoprotein with a 40 year duration
- Protects mycrorhizae from microbial attack
- Prevents leakage in transport mechanism
- The higher the atmospheric carbon ppm (670), the fungi grew 3 x faster and produced 5x more glomalin

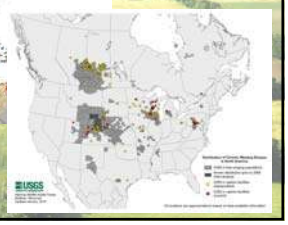
31

Soil Organic Matter

- Chronic Wasting Disease (CWD)
- Soil humic acids degrade CWD prions and reduce infectivity

32

Compaction vs CWD



Crop Diversity

- Modern seed bred for stability, repeatable performance and high yield
- Regional seed becomes better adapted
- Can create regional 'specialties' (Slow food)
- Open pollinated
- Plastic genome
- Disease synchronicity

34

Old Genetics

- Ancient grains, landrace / heritage
- Heritage varieties have genome still intact
- Often polyploidy
- Better response to restored environment
- Epigenetic mechanism still active
- May retain ability to communicate above and below ground

35

Benefits of diversity

- Spread out planting / harvesting
- Mitigate crop impacts from climate change
- Mitigate disease through long rotations
- Use 1 crop "waste" as input for another another
  (e.g. straw – garlic/hops)
- 1 crop failure has smaller net impact
- Every year there is one stellar performer

36

Why do all this?

Goods and Services Restoration

Value Cost Worth
Diversity Resiliency Stability
Plasticity Elasticity
Consumer Investment

37

Philosophies
Value Cost Worth

- The ecological goods and services that a diverse ecosystem provide are worth more than the revenue from the land that supports these services
- Nature works at a scale we cannot even image
- Nature is more efficient than we can imagine
- Nature is more complex than we can understand

38

Philosophies
Diversity Resiliency Stability

- Any practice that will mitigate extreme weather events: extreme heat, extreme precip, extreme drought, extreme wind, will pay in spades.
- This includes trees, shelter belts, soil organic matter and mycelium, flora/fauna.
- Historically, agriculture was based on stability (sustainability).

39

Philosophies
Plasticity Elasticity

- Landrace heritage germplasm better adapted to climate extremes. Most modern varieties have been bred for high inputs and stable climate.
- Save “all” seed, it has the genetic legacy
- Saving the best seed from last year, selectively breeds for the past.
- Want plasticity and resiliency – yields may be lower, but consistent.

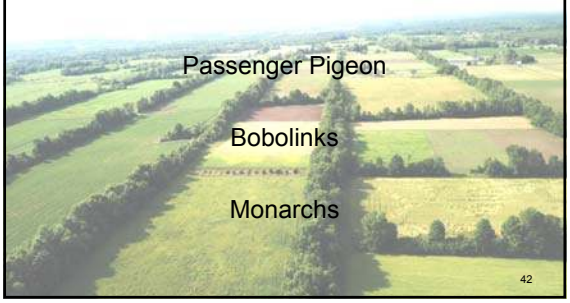
40

Philosophies
Consumer investments

- Knowing customers adds a level of intent
- Customer are the beneficiaries of the ecological goods and services that farm provides
- Customers are the ‘investors’ and the ecological goods and services are their dividends
- You should keep the ‘profits’ of your labour

41

Strange connections



Passenger Pigeon

Bobolinks

Monarchs

42

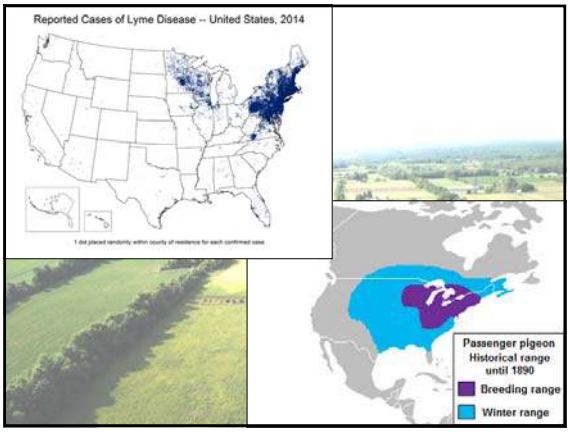
Passenger Pigeon and Lyme Disease

- 3-5 billion in number
- Communal nest sites of 850 sq miles
- Extinct 1914
- Consumed acorn and beech nuts

- Disease vector is Acorn / deer - rodent / tick / limes disease / climate change
- Annual health care costs now approaching $1.4 billion
- Correlation: limes increased 2 years after nut mast year

Billing pair by John James Audubon, from The Birds of America, 1827–1838

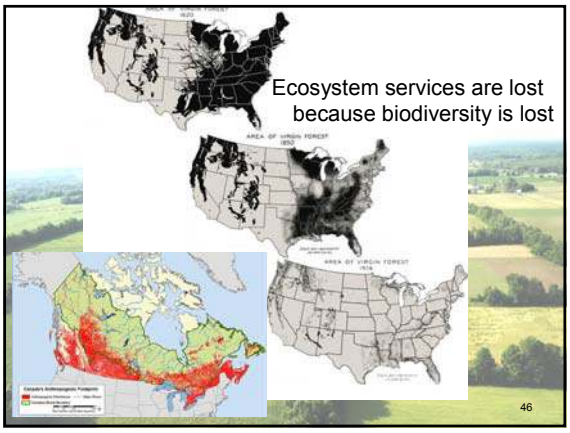
43



The Tree Back Story

- Trees share carbon
- Beech groves
  - Average carbon sequestration across grove
  - All trees in a grove share photosynthetic benefit
- Oak mast years
  - Mycelium transport of carbon to ensure all trees have sufficient reserves to mast
  - Survival strategy for nut germination

45



The Back Back Story

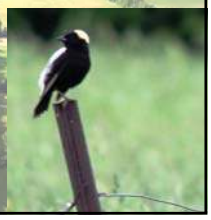
- No pigeon bone in the indigenous middens
- Prior to epidemics, nuts were collected, there by limiting pigeon populations
- Ecological release resulting from 1st contact
- 90-95% morbidity resulting from:
  - Smallpox, Measles, Influenza, Typhus
- Removal of 'top predator' released pigeons

47

Field Nesting Birds

- Bobolinks, Eastern Meadowlark
- 95% return to successful fledge fields
- 20K km migration, iron-oxide in nose hairs
- Restoration plan continue farmer exemption

- What is their ecological role?
- Not species at risk – habitat at risk
- Farm as refugee camp?
- Will they be part of a disease vector in 2097?



Fungi – Plant – Parasite - Insect

- 4 generation to migrate here
- 1 generation back to Mexico

- Symbiotic mycorrhizal increased levels of cardinolides in milkweed
- Monarch butterfly select milkweed with higher levels
- Selective egg laying for increased young survival
- Self medicated caterpillars against parasites and predation

Can they navigation back to the stable milkweed supply?

"The reason trees share food and communicate is that they need each other. It takes a forest to create a microclimate suitable for tree growth and sustenance.

Perhaps the saddest of all plants are those we have enslaved in our agricultural systems.

Perhaps farmers can learn from the forests and breed a little more wildness back into their grain and potatoes, so they will be more talkative in the future."

The Hidden Life of Trees, Wohlleben

Hope is within us,
as much as hope is between us

We are Climate Pioneers
Proactive and Constructive

Instagram: IronwoodOrganics