

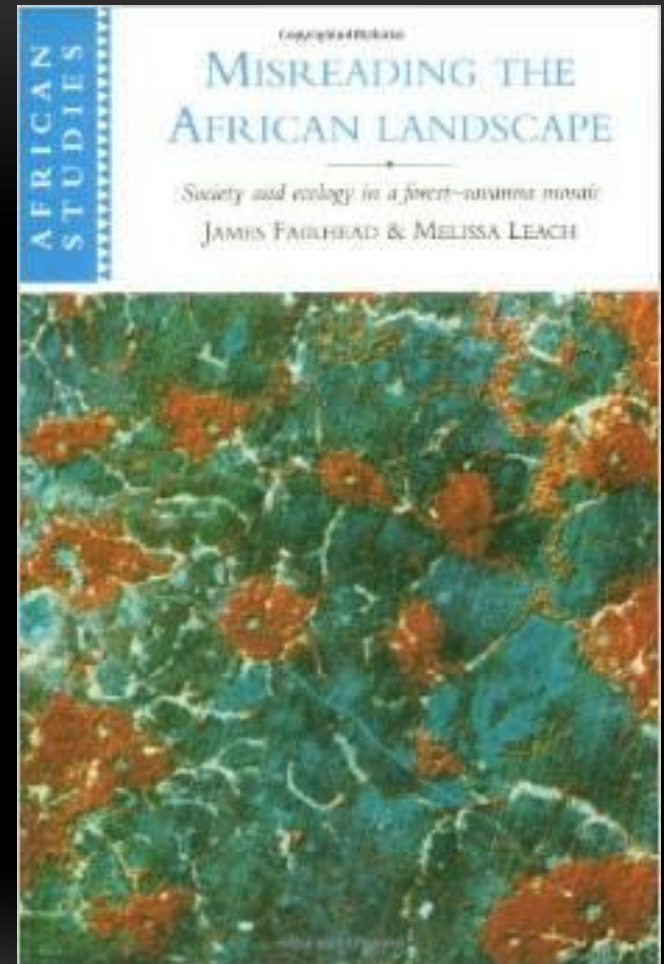


LAND SPARING VERSUS LAND SHARING: HOW MIGHT BIODIVERSITY AND BIOENERGY COEXIST?

Audrey L. Mayer (almayer@mtu.edu)
Michigan Technological University
School of Forest Resources and Environmental Science
Department of Social Sciences
Houghton, MI USA

MODERN HUMAN LAND USE AND BIODIVERSITY LOSS

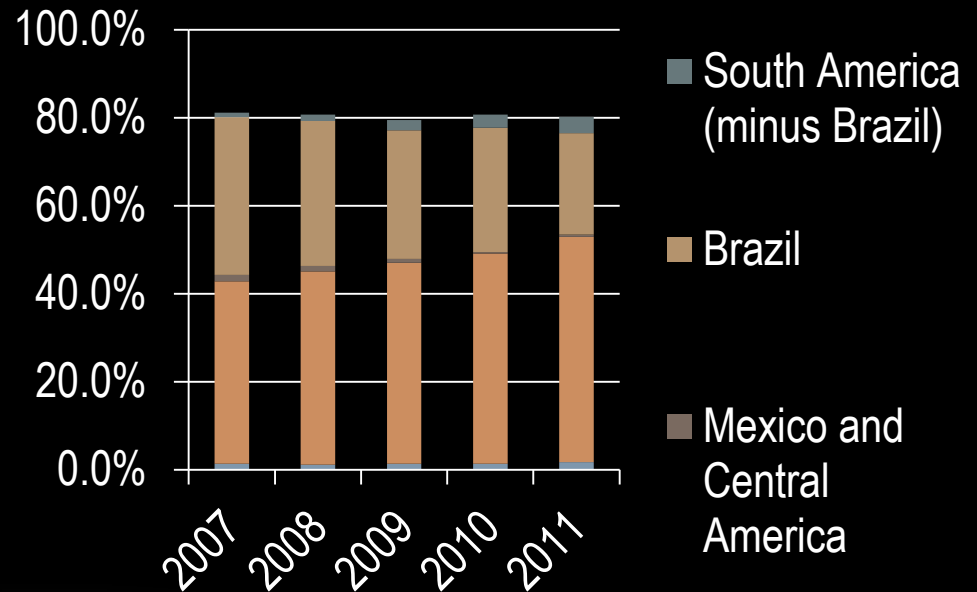
- Human land use does not automatically lead to less biodiversity
 - Terra preta soils in Amazon
 - Forest islands in savanna in Africa
- In this talk, bioenergy production \approx agriculture
 - Food, fiber, fuel
 - Intensive industrial
 - High diversity, polyculture



BIOENERGY PRODUCTION IN DIVERSE AREAS

- Countries in western hemisphere producing much of the world's biofuels at present
 - Volume vs. hectare
- The hemisphere has many biodiversity hotspots, including high biodiversity biomes that have been substantially reduced by land use change
 - Tallgrass and shortgrass prairies of North America
 - Atlantic forest, cerrado in Brazil

Percent of total global biofuels production, by volume



LAND SPARING (OR LAND INTENSIFICATION)

- Isolate production to as small of an area as possible
 - Allows for maximum land area for biodiversity and intact ecosystems
- Use all technology available to produce maximum yields
 - Fertilizers
 - Pesticides
 - Genetic modification
 - Antibiotics/hormones



Photo: Garth Lenz (www.garthlenz.com)



Photo:
Wired
Magazine/
Mishka
Henner

LAND SHARING

- Agroforestry or agroecology
 - Planting food and medicinal crops interspersed to create a structure similar to native habitat
 - Shade-grown coffee
 - Intercropping of grains and seed crops in grassland/prairie
- Polyculture or permaculture
 - Using perennials instead of annuals to produce food



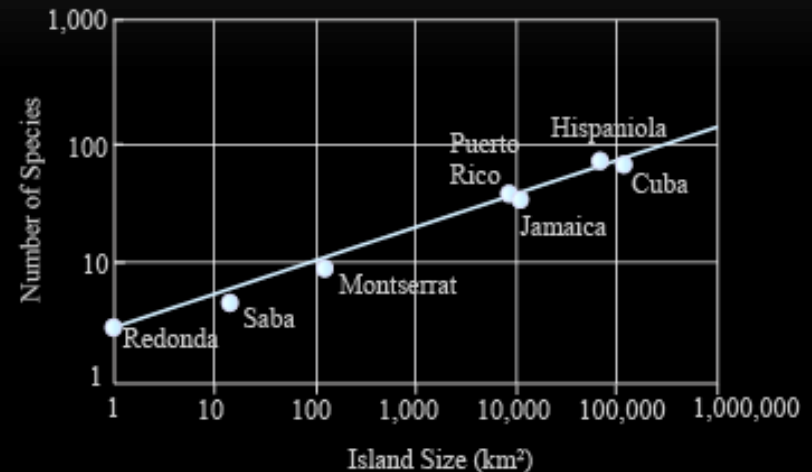
Photo: Arbor Day Foundation



Photo: The Land Institute

PRO-LAND SPARING

- Maximize diversity of ecosystem services
- Island Biogeography Theory
 - Species-Area curve: more area supports more species
- Landscape Matrix
 - Flip land use so that intensive agriculture are islands in a sea of natural land cover
 - Reduction in pests
 - Buffers for runoff



Amphibian and reptile species in Caribbean

LAND SPARING AND BIOENERGY PRODUCTION

Hybrid Poplar for cellulosic ethanol,
bio-oil, wood chips



Photo: Michigan State University

Switchgrass for cellulosic ethanol,
pellets

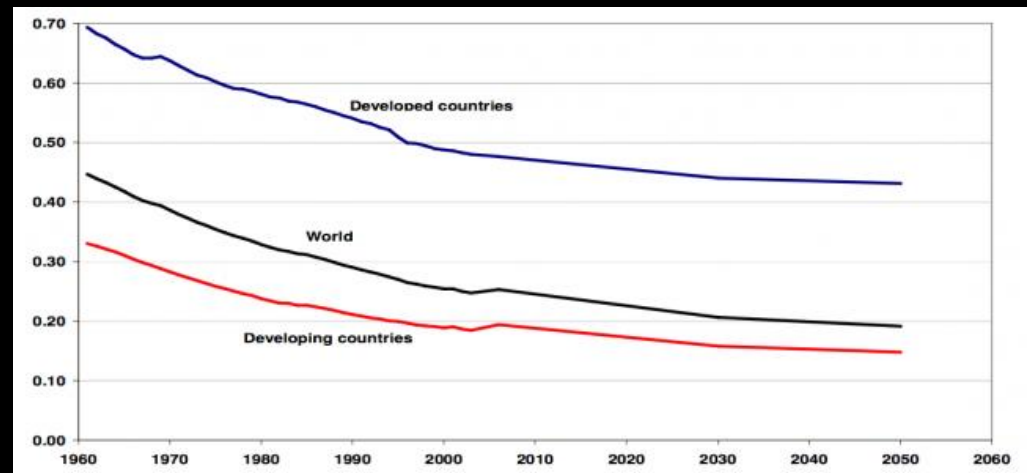


Photo: Paul Knox

ANTI-LAND SPARING

- Can impacts of high-intensity production be isolated to production fragments?
 - DNA drift from GMO varieties
- How much can we compress agriculture and still meet demand?
 - Food
 - Energy
 - Fiber
 - What are limits to land productivity?

Arable land per capita (ha in use/person)



Jelle Bruinsma (2009) FAO

PRO-LAND SHARING

- Agriculture (and bioenergy) production can:
 - Mimic structure of natural habitats
 - Support some biodiversity
 - Provide some ecosystem services
- Patches of mixed production would have less sharp edges/boundaries with natural patches



Photo: Polyculture Design

LAND SHARING AND BIOENERGY PRODUCTION

Wood pellets from forest harvest residues of boreal forests (Sweden)



Photo: SCA Group

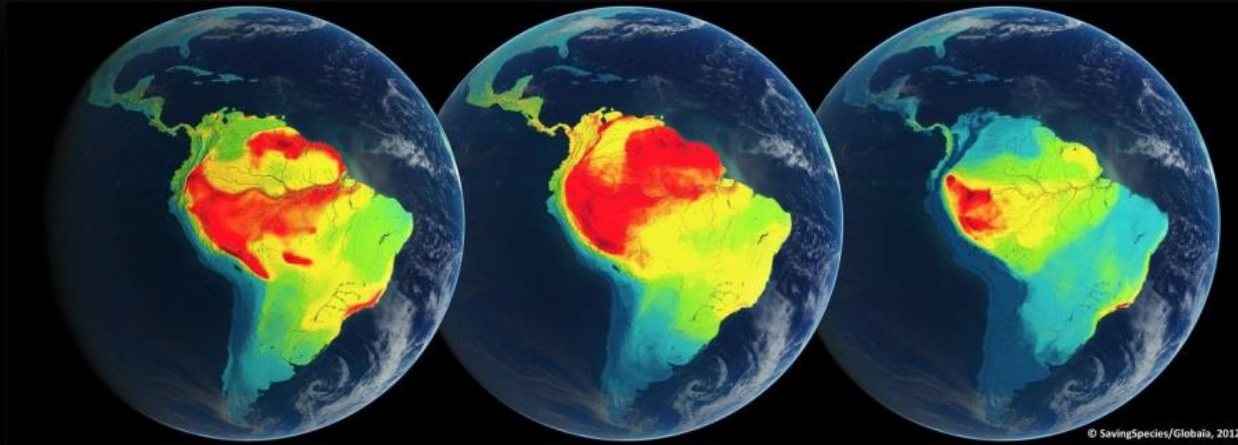
Cellulosic biofuels from tallgrass prairie (Wisconsin)



Photo: University of Wisconsin

ANTI-LAND SHARING

- Even diverse production areas may support fewer species, and support fewer rare, endemic, or specialist species
- Far more land is required to produce same amount of bioenergy
- May be difficult to regulate



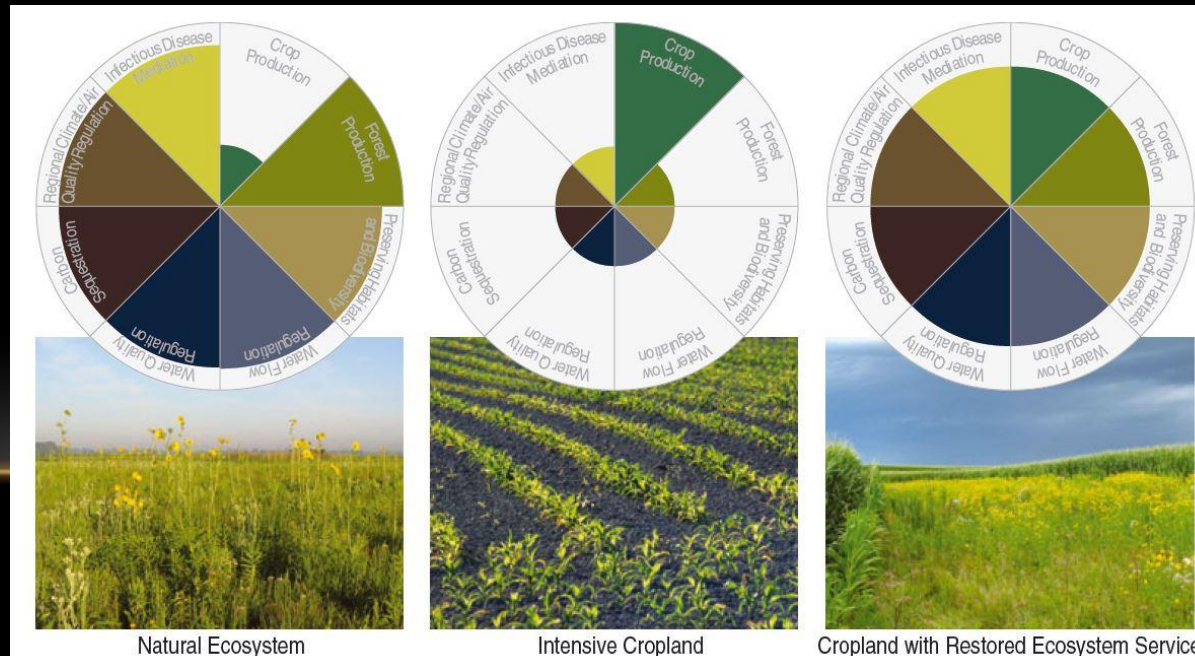
Density of endemic birds, mammals and amphibians in Central and South America. Image: Clinton Jenkins

ANDERSON-TEIXEIRA ET AL. 2012, *ECOLOGICAL APPLICATIONS*

- Model compares land sharing vs. land sparing and impact on greenhouse gas regulation
- Advantages of land sparing vs. land sharing depend upon type of ecosystem displaced
- Average GHG regulation is maximized through land sparing scenarios
 - *“Whenever bioenergy crops have substantially low ecosystem services than the ecosystems with which they are competing for land, the most effective strategy for meeting bioenergy demand while maximizing ecosystem services on a landscape level is one of land sparing”*
 - Probably a similar case for biodiversity as well
- Caveats: GHG regulation not dependent upon landscape spatial configuration of land use types

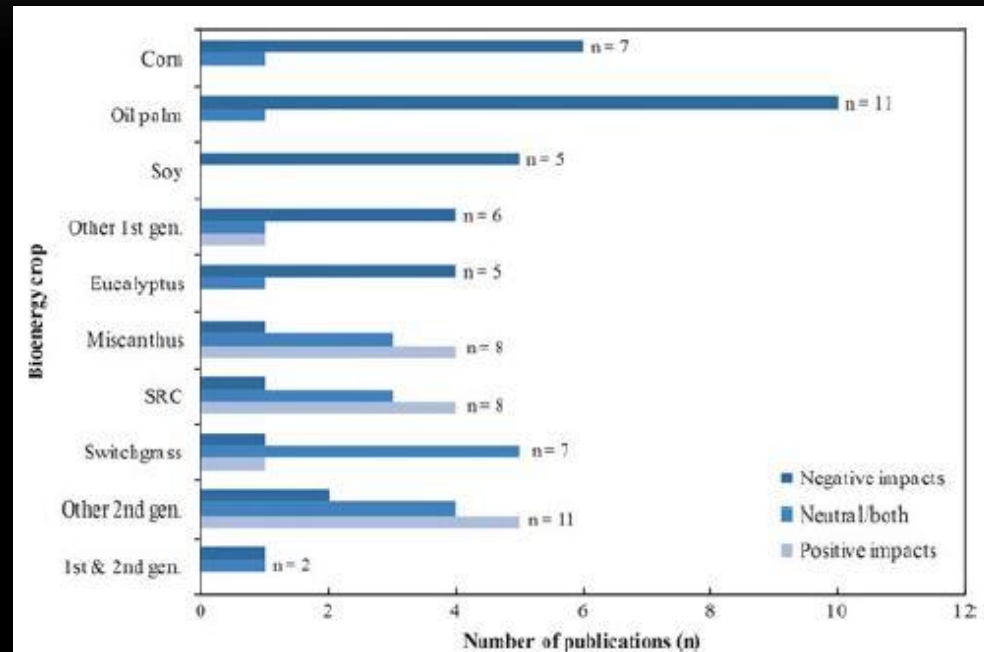
HEATON ET AL. 2013, *BIOFUELS BIOPRODUCTS & BIOREFINING*

- Room for intensification in developing countries
 - Higher yields on existing ag land possible
 - Prevent conversion of high diversity natural areas
- Could increase diversity in production areas in developed countries
 - Yield already probably at maximum
 - Increase ecosystem services in existing ag lands



IMMERZEEL ET AL. 2014, *GLOBAL CHANGE BIOLOGY BIOENERGY*

- Reviewed 53 publications on bioenergy and biodiversity
- Lots of discussion on land sparing vs. land sharing, but not much data
- Understanding how bioenergy and biodiversity can coexist must include indicators at both the field and landscape scale
 - Impact of bioenergy production on landscape heterogeneity is key



CONCLUSIONS?

- Land sparing vs. land sharing decisions likely to be highly context-specific:
 - Type of biomass
 - Method of harvest
 - Temperate vs. tropical
 - Existing landscape heterogeneity
 - Rare/endemic species
 - How do existing policies (e.g., renewable fuels standards) drive land use decisions?
 - As always, more research needed
-



Photo Courtesy Michigan Tech Archives

THANK YOU!

QUESTIONS?