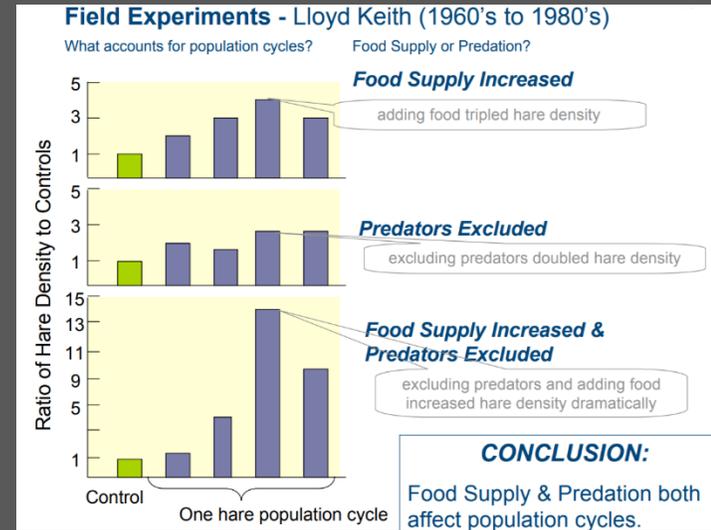
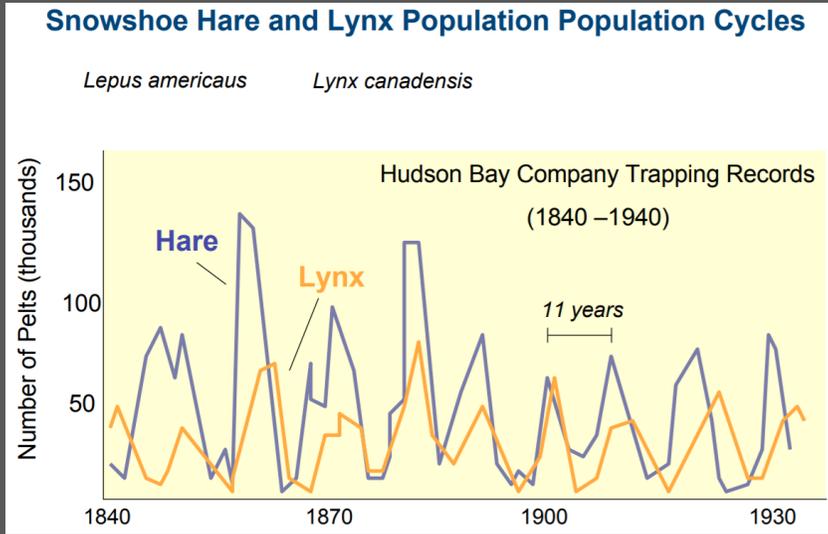


A high-angle, close-up photograph of a mangrove forest floor. The ground is covered with a complex, dense network of light-colored, woody tree roots. The roots vary in thickness and are intertwined, creating a web-like pattern. Small green plants and fallen brown leaves are scattered among the roots. The overall scene conveys a sense of interconnectedness and natural complexity.

CONNECTED NATURE

THEORIES - MODELS - DATA



PREDATION AND EVOLVING CONNECTIONS

Chemical Defences - Cryptic Coloration - Physical Defences - Mimicry



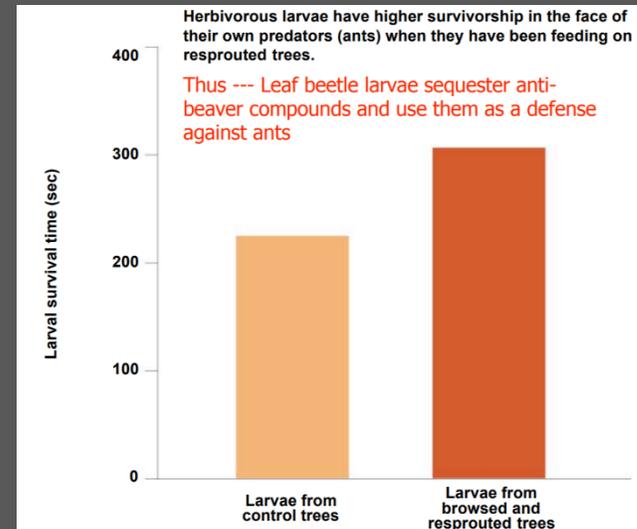
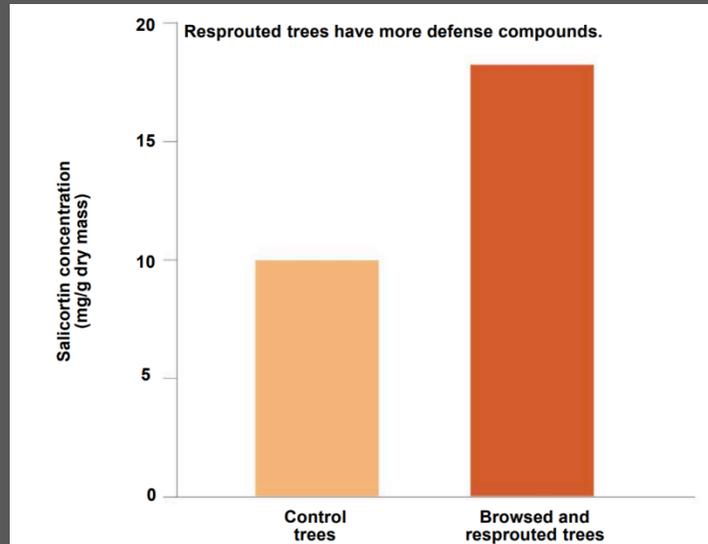
Castor canadensis



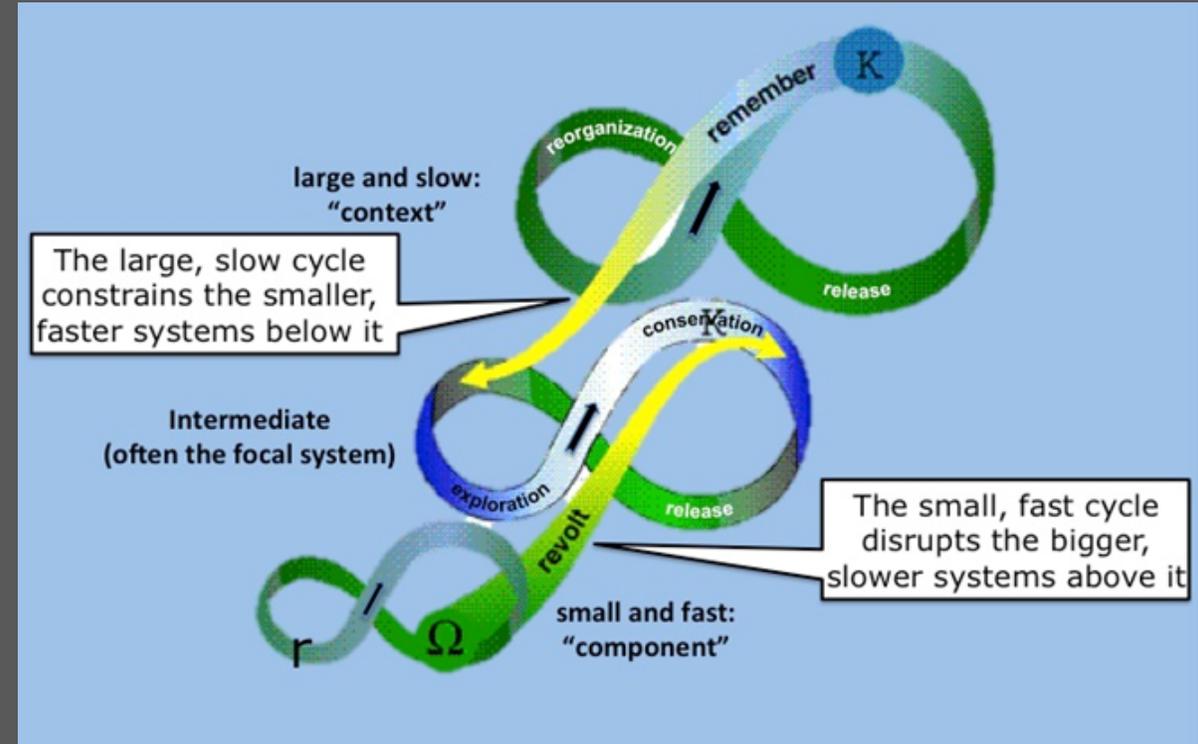
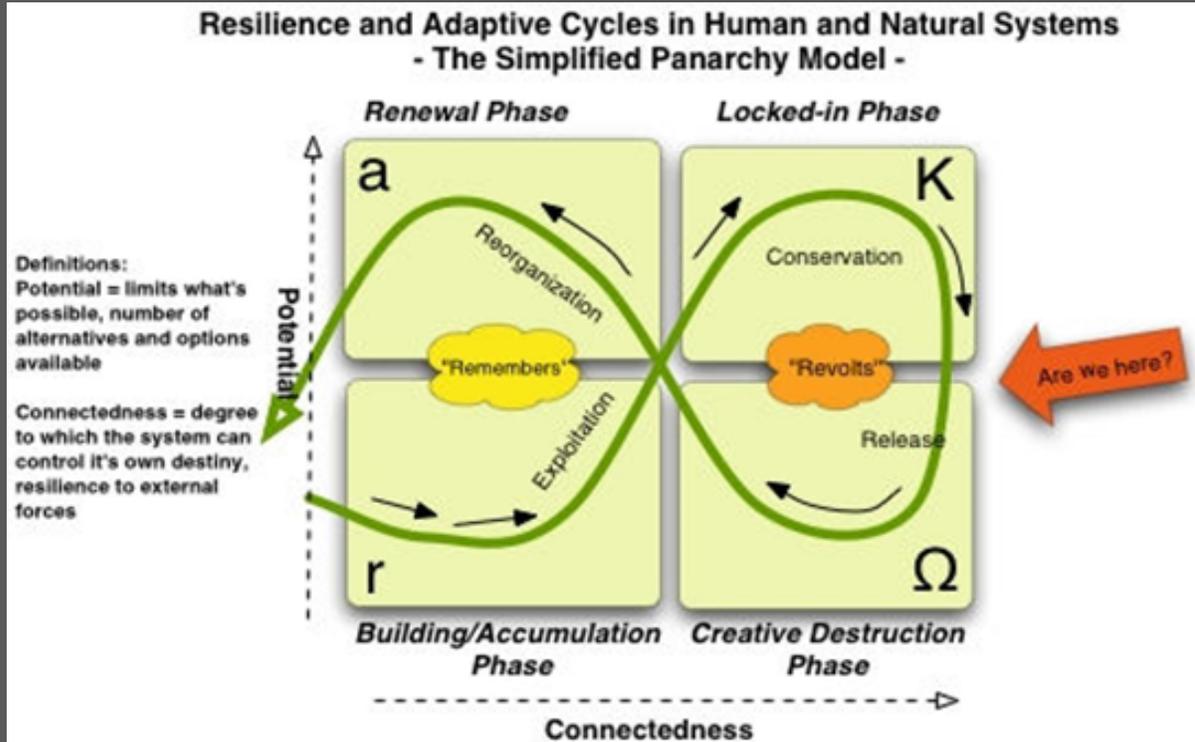
Chrysomela confluens



Populus fremontii angustifolia



Resilience - Panarchy



DIVERSITY APPROACH

Table 1. An explanation of the construction of equation (1)

term in equation	interpretation
$1 + b_1$	prey's unconstrained birth rate
$-\alpha \frac{x_1}{x_3}$	decrease in fitness of prey due to resource limitation
$-c_1 \frac{x_2}{1 + d_1 x_1}$	decrease in fitness of prey due to predation
$1 - d_2$	predator's unconstrained death rate
$e_2 x_1$	predator's fitness increase due to feeding
$1 + b_3$	resource's unconstrained reproductive rate
$-\frac{x_3}{k}$	resource's carrying capacity limitation
$-c_3 x_1$	resource's fitness decrease due to feeding by prey

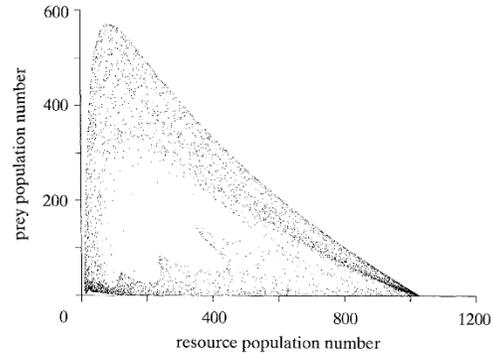
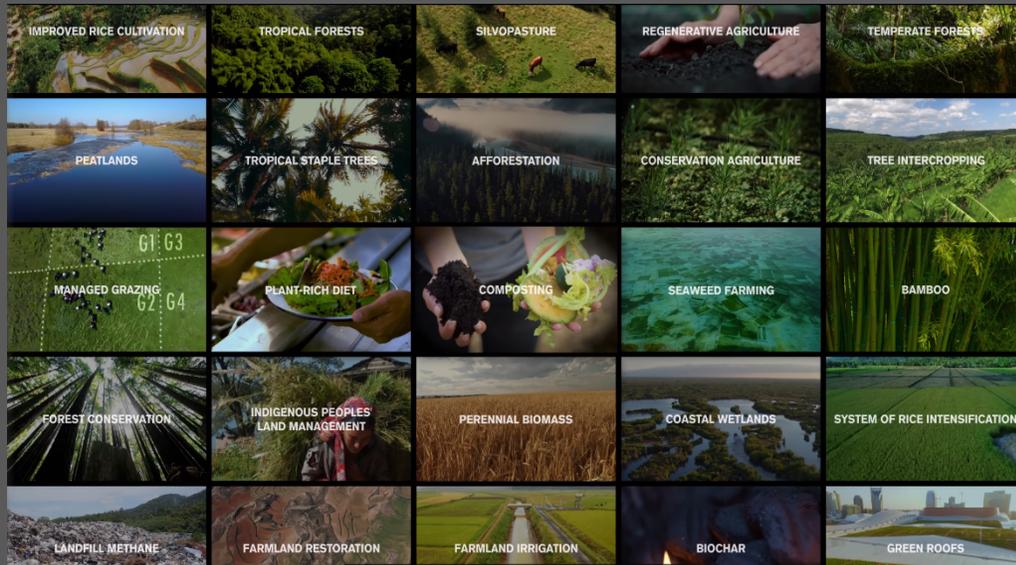


Figure 1. A two-dimensional projection of the attractor for equation (1) with the first set of parameters as in table 2.

Variables approach



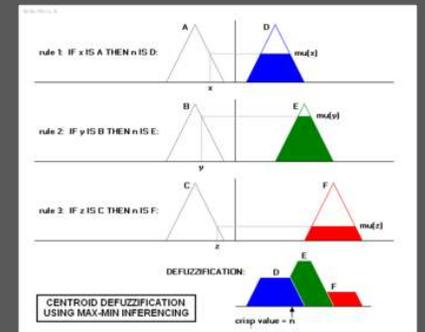
Case Studies approach

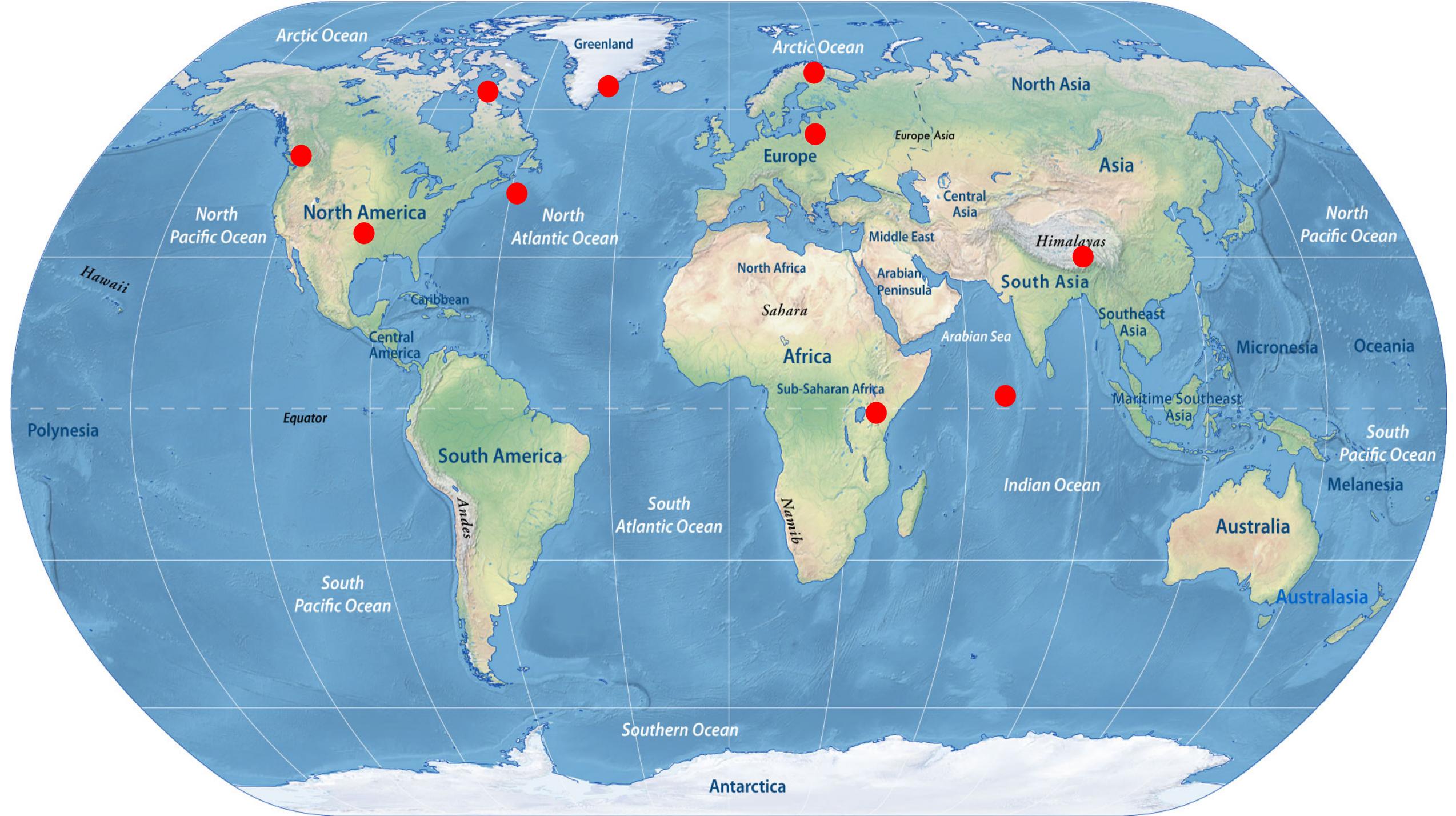
Fuzzy Logic approach

Complex causalities can be made explicit through the rules that describe fuzzy sets with overlapping memberships to account for uncertainty

Classes of ecosystems can be treated as fuzzy sets with partial memberships

Individual cases can be members of multiple sets





COMMON NAME: Monarch butterfly
SCIENTIFIC NAME: *Danaus plexippus*
AVERAGE LIFE SPAN: Six to eight months
SIZE: Wingspan 10 cm
WEIGHT: Less than 1 gm



A SINGLE FOOD SOURCE – TOXIC TO OTHERS



The Monarch butterfly relies on a single plant species – the milkweed – for food. Its toxic chemistry gives the butterfly protection from predators.

There are over 100 native species of milkweed (*Asclepias* spp.) in North America

Because of agricultural herbicides and other human interference with nature, milkweed plants are not as widely available for monarchs.

Western Monarchs have declined by more than 99 per cent since the 1980s, and Eastern Monarchs by 80 per cent. www.monarchwatch.org

A SINGLE MOTH SPECIES – DEVASTATING FORESTS



The Spruce Budworm (*Choristoneura fumiferana*) is a moth native to North America.

It feeds mainly on balsam fir and white spruce. Trees usually die after four or five consecutive years of severe defoliation.

Outbreak cycles of spruce budworm occur every 30 to 40 years. During an outbreak, tens of millions of hectares of trees can be severely defoliated. An outbreak may last several years.

By 2019, over 9.6 million hectares of forest in Quebec has suffered moderate to severe defoliation.

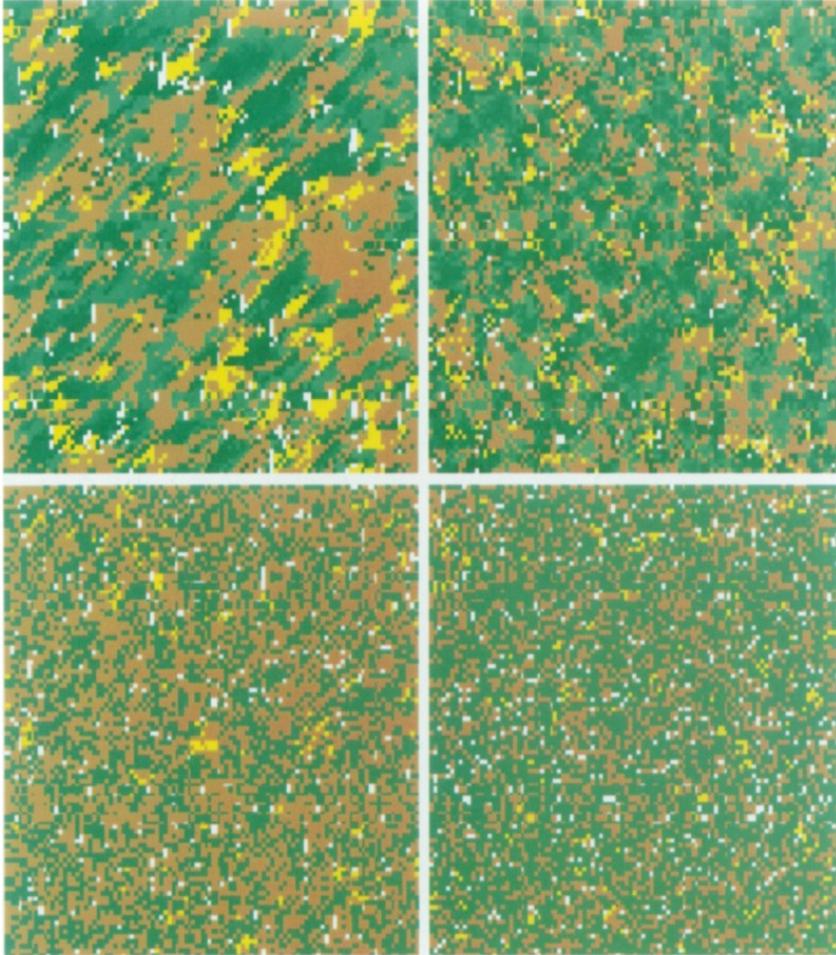


A photograph of a dense forest with tall, thin trees and a thick canopy of green leaves. In the foreground, a large, fallen log is covered in vibrant green moss. The forest floor is also covered in various green plants and ferns. The overall scene is bright and vibrant, with sunlight filtering through the trees.

THE ROLE OF MEMORY IN ECOSYSTEMS

R. J. Hendry and J. M. McGlade (1995) The Role of Memory in Ecological Systems.
Proceedings of the Royal Society: Biological Sciences, Vol. 259:153-159

500 YR MOSAIC CYCLE IS DRIVEN BY SOLAR RADIATION ABOVE GROUND AND SUSTAINED BY THE MICROBIAL NETWORK BELOW GROUND



Cellular automaton model



Solar radiation effects in a beech

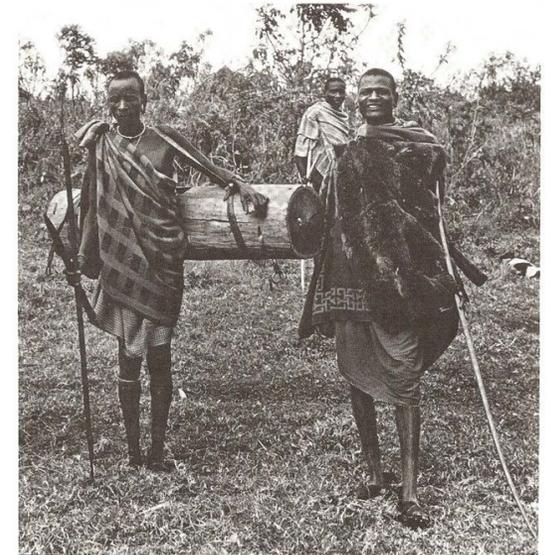
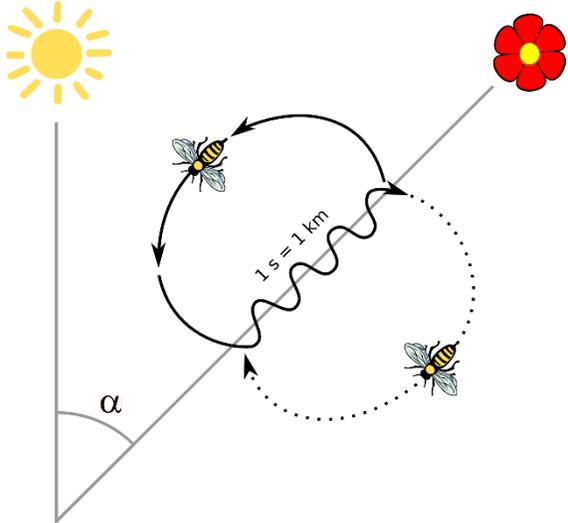


Mycorrhizal network in soil



NATURE'S NETWORKS ARE EVERYWHERE

INSECT CONNECTEDNESS AND COMMUNICATIONS



Bee Dance of eight; Ogiek nurture different wild bees African honey bee & stingless Segemiat; Ogiek hive and harvested honey for sale in the Mau

Bee dance Emmanuel Boutet Apis mellifera MK <https://commons.wikimedia.org/w/index.php?curid=15242410> and 44918233

CHAGOS ISLANDS CONNECTING RATS, BIRDS, FISH & CORALS

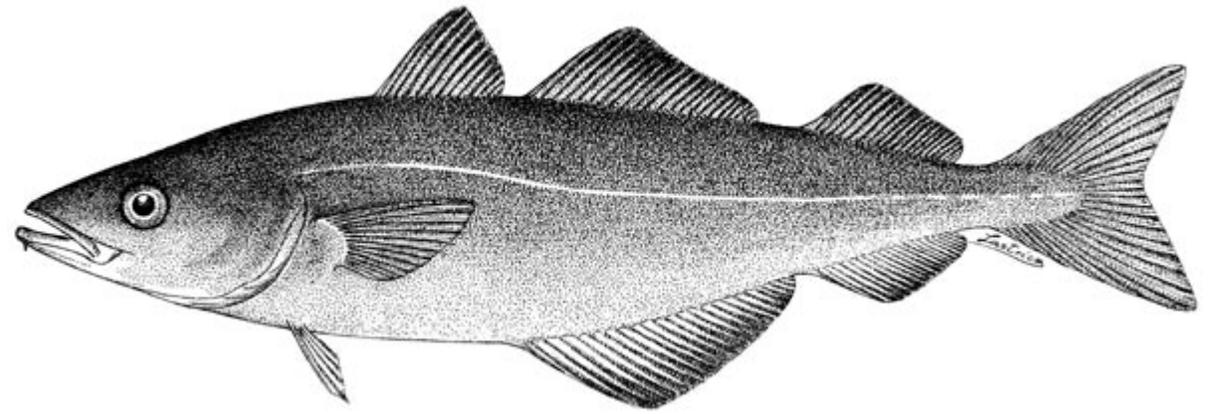
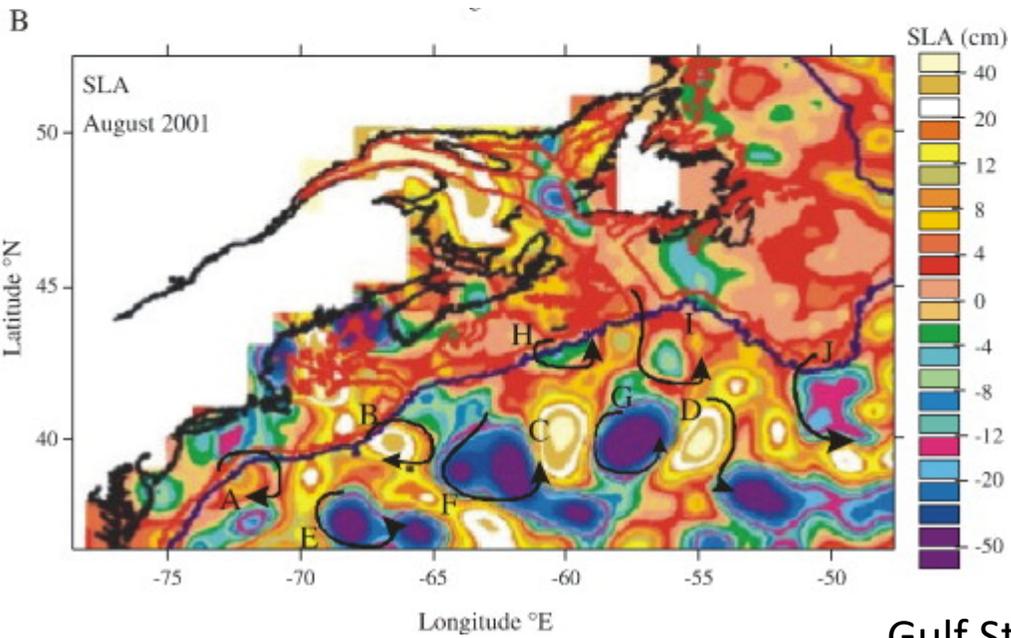


©Anne Sheppard



Photos: Chagos Conservation Trust,
Anne Sheppard, Jon Slayer

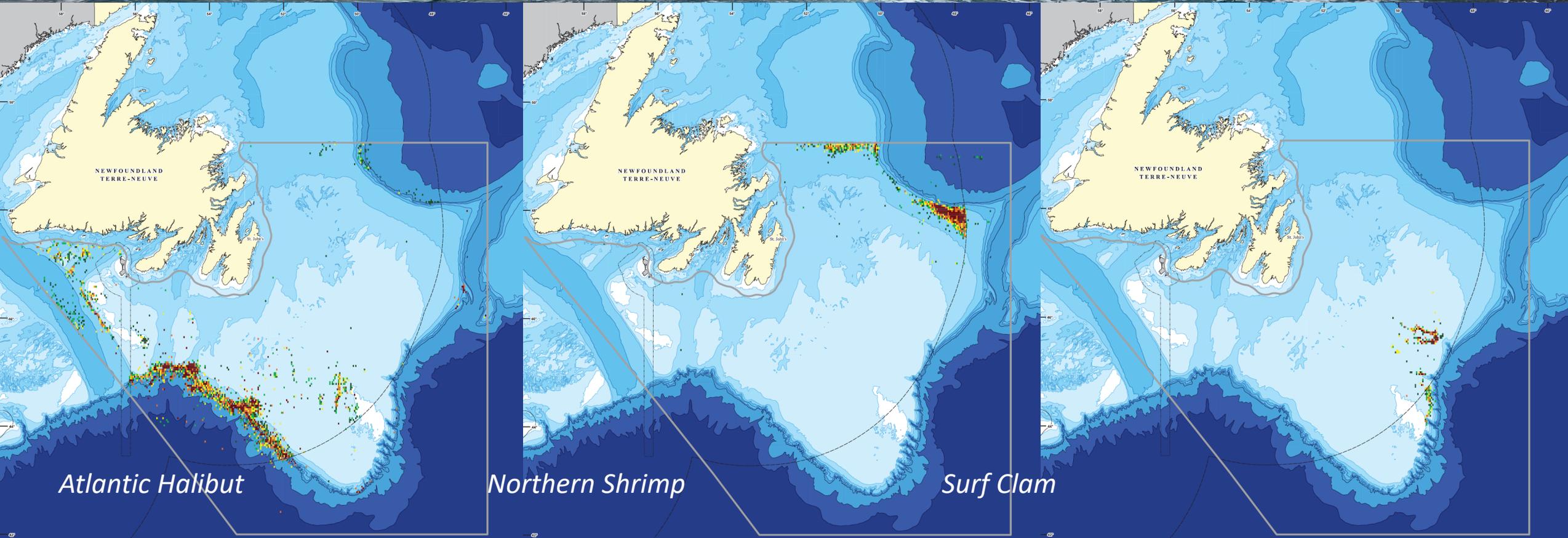
CANADIAN ATLANTIC GULF STREAM AND FISH RECRUITMENT



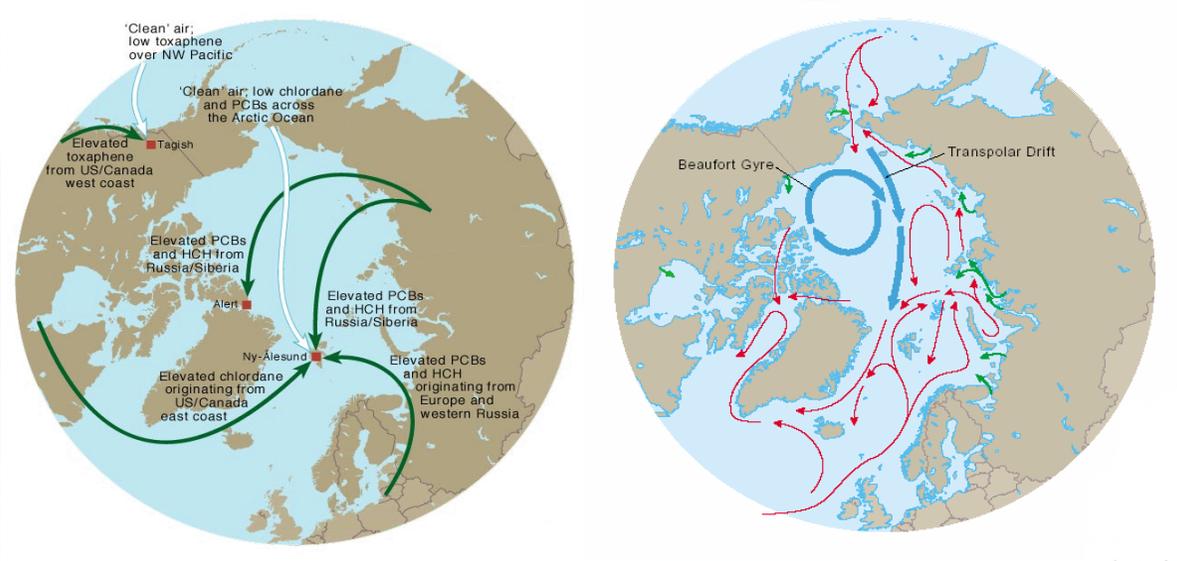
Pollachius virens L.

Gulf Stream Warm Core Rings – arrows showing direction of water flows

CANADIAN ATLANTIC DEEP OCEAN SPECIES SPATIAL PATTERNS



NEW ARCTIC PATHWAYS AND CONNECTIONS



Pollutants

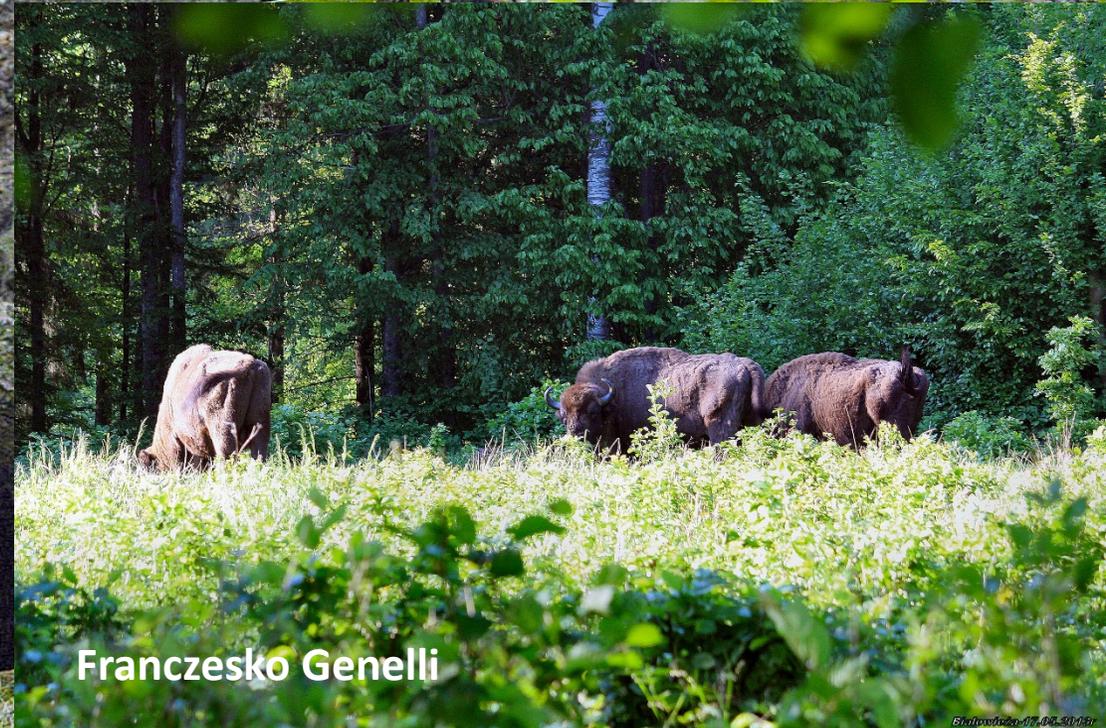
Air – the fast route Rivers, oceans & sea ice



New Migratory Routes

New Alien Routes

PRIMAЕVAL FORESTS OF BIAŁOWIECZA



Franczesko Genelli