University Honors College & College of Science
Mixer

November 8, 2013

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Physics

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A Mass Extinction Event in Our Time

5,743 species of amphibians

45% in decline

More than 33% threatened

More than 130 species extinct since 1980

“many endangered”

Scientists Detect Mysterious Decline In Global Populations of Frogs, Toads

FROGS, From A1

salamanders often rise and fall naturally. But the scientists are concerned because the animals in many locales do not appear to be rebounding. They are especially concerned because many of these local extinctions are occurring in relatively pristine habitats such as national parks and biological reserves.

"Amphibians are disappearing and we're not sure why," said Roy McDiarmid, a herpetologist with the U.S. Fish and Wildlife Service and the National Museum of Natural History. "We have to ask whether this is a general indication of environmental degradation."

To unravel the mystery of their disappearance, and to better document how extensive the decline is, the researchers have rushed to organize a meeting early next year entitled "Declining Amphibian Populations—A Global Phenomenon?"

In the last few years, researchers have witnessed severe reductions and local extinctions throughout tropical Central and South America, Europe and North America.

"Decline is very evident and very rapid in Europe," said Hansjurg Hotz of the University of Illinois in Urbana. Hotz said the decline is most dramatic in Central and Northern Europe.

Jay Savage of the University of Miami said the trend in the tropical New World is also toward fewer animals and local extinctions. Savage himself has watched a brilliantly colored amphibian called the golden toad falter in the cloud forests of Costa Rica.

Others have seen marked declines of salamanders in Mexico, toads in Peru and several species of

“What we're seeing is a decline of all native frogs from British Columbia to Southern California to the Rocky Mountains in the east.”

— Andrew Blaustein of Oregon State

frogs in Brazil. Some of the most precipitous declines have been observed in North America, particularly in the West.

"What we're seeing is a decline of all native frogs from British Columbia to Southern California to the Rocky Mountains in the east," said Andrew Blaustein of Oregon State University, who has watched numbers of the western spotted frog and the Cascades frog drop in Oregon.

"There is a real strong feeling in the West that amphibians are taking a nose dive," said David Bradford of the University of California at Los Angeles.

Where hundreds of yellow-legged frogs once crowded the shorelines of mountain lakes in the Kings Canyon and Sequoia National Parks in California, Bradford finds few frogs today. Only one of the 38 lakes that Bradford has surveyed has yellow-legged frogs. A frog watch last summer by park rangers in the back-country found that the frogs were still present, but their distribution was patchy.

Stephen Corn and Bruce Bury of the U.S. Fish and Wildlife Service's National Ecological Research Center in Colorado have documented dramatic declines of the boreal toad and the leopard frog in the Rocky Mountains.

"We sense there is something wrong. The frogs aren't here anymore," said Bury. "We don't know why these animals are going down or why they are not recovering."

The mystery of the disappearing frogs is complicated by the fact that in some areas, researchers have found no decline. Researchers who work in Borneo and East Africa, for example, report no detectable downward spiral. Also, in the Southeastern United States, several scientists report the populations appear to be holding steady, while others have seen declines.

"There are just a helluva lot of unanswered questions," said McDiarmid.

ENVIRONMENT

Bad Days on the Lily Pad

Deformed frogs are turning up in dozens of states, and scientists finally have suspects

By Sharon Begley

Every time herpetologist David Hoppe goes for a nature walk, his colleagues at the University of Minnesota brace themselves. Hoppe doesn't return with pretty wildflowers. He brings back frogs with deformities like missing legs or extra ones, missing eyes or missing jaws. But even in this sideshow, the latest frog Hoppe brought back from a pond stood out: it had two sets of hindquarters. Attached to the torso by a thread, the extra posterior and pair of legs had no nerves and so dangled around pathetically. "It's getting to be a real freak show in the lab," says a colleague sadly.

And the show goes on, and on. In the three summers since a class of Minnesota kids on a field trip found a pond full of northern leopard frogs with extra hind legs and other deformities, kicking off a media frenzy, amphibians with severe developmental defects have turned up in a dozen states. Early hopes that the deformities would turn out to be nothing new have fizzled: Hoppe reported recently that, in Minnesota, abnormalities were "more frequent, more varied [and] more severe" in 1996 and 1997 than in the nearly 40 years before. And it doesn't seem as if the surge in deformities reflects only "reporting bias"—that the more people look for something, the more they find. At one Minnesota pond 70 percent of frogs have deformities. This compares with a historical "background" level of less than 1 percent. Scientists are now trying more urgently than ever to figure out what is causing it; a leading suspect is overexposure to environmental retinoids, hormones that at levels even slightly above those naturally present in an animal cause birth defects. If retinoids are responsible, then frogs, which scientists view as a "sentinel species" because they are among the first to suffer from environmental degradation, may not be the only ones in danger. "Frog malformations," says chemist David Gardiner of the University of California, Irvine, "have very, very strong implications for human health."

That's a possibility the government is now taking seriously. In March, Gardiner briefed cabinet officials involved in environment and wildlife. But a few weeks ago he flew back to Washington to meet with Donna Shalala, secretary of Health and Human Services, and Dr. Harold Varmus, director of the National Institutes of Health. And finally, after keeping the research largely to itself, the government is making grants to outside scientists so they, too, can tackle the case of the deformed frogs.

One early suspect was increased ultraviolet light due to thinning of Earth's ozone layer. Although research continues on this, "UV just doesn't give you the deformities we find in the field," says biologist Bruce Blumberg of the Salk Institute in La Jolla, Calif. Also, there is no obvious reason that when two ponds receive the same amount of UV, one has scores of deformed frogs while the other has none. Parasites, too, were early suspects. In California ponds, biologist Stanley Sessions of Hartwick College in upstate New York found hundreds of deformed frogs. In the hind-limb buds of some tadpoles were trematode cysts. Trematodes are parasitic flatworms. Sessions has now microsurgically implanted trematode cysts into tadpoles "and, in preliminary results, we have produced [extra] limb outgrowths, though not full limbs," he says. The parasite theory has some problems, though. Many normal frogs do contain trematodes, while a large percentage of deformed frogs do not.

That leaves "something in the water," says toxicologist James Burkhart of the National Institute of Environmental Health Sciences, part of NIH. Frogs that spend most of their lives in water—green, mink and northern leopard frogs—have higher rates of deformities than do terrestrial species like the gray tree frog, wood frog and spring peeper, Hoppe found. The deformities seem to reflect the disruption of a developmental pathway governed by frogs' thyroid hormones and retinoids. Scientists are therefore searching for water pollutants that mimic retinoids. David Gardiner examined 29 frogs from one hard-hit pond in

Freak show: *Did parasites give this tree frog extra legs?*

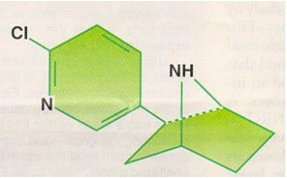
Jumping to Conclusions

What's causing the frog deformities? Scientists have posed numerous theories and are now zeroing in on a few.

- **Retinoids** Synthetic and natural compounds known to cause birth defects in birds, frogs and mammals (including humans).
- **Trematodes** These parasites form cysts that may, in tadpoles, cause extra limbs to sprout. But not all deformed frogs have cysts.
- **UV radiation** A known mutagen. More UV-B is reaching Earth's surface now due to the thinning of the ozone layer.
- **Injury** Young frogs that lose a leg may grow multiple replacements. But the deformed frogs' legs differ in structure from the regenerated kind.
- **Methoprene** Commonly used insecticide that can break down into retinoids.

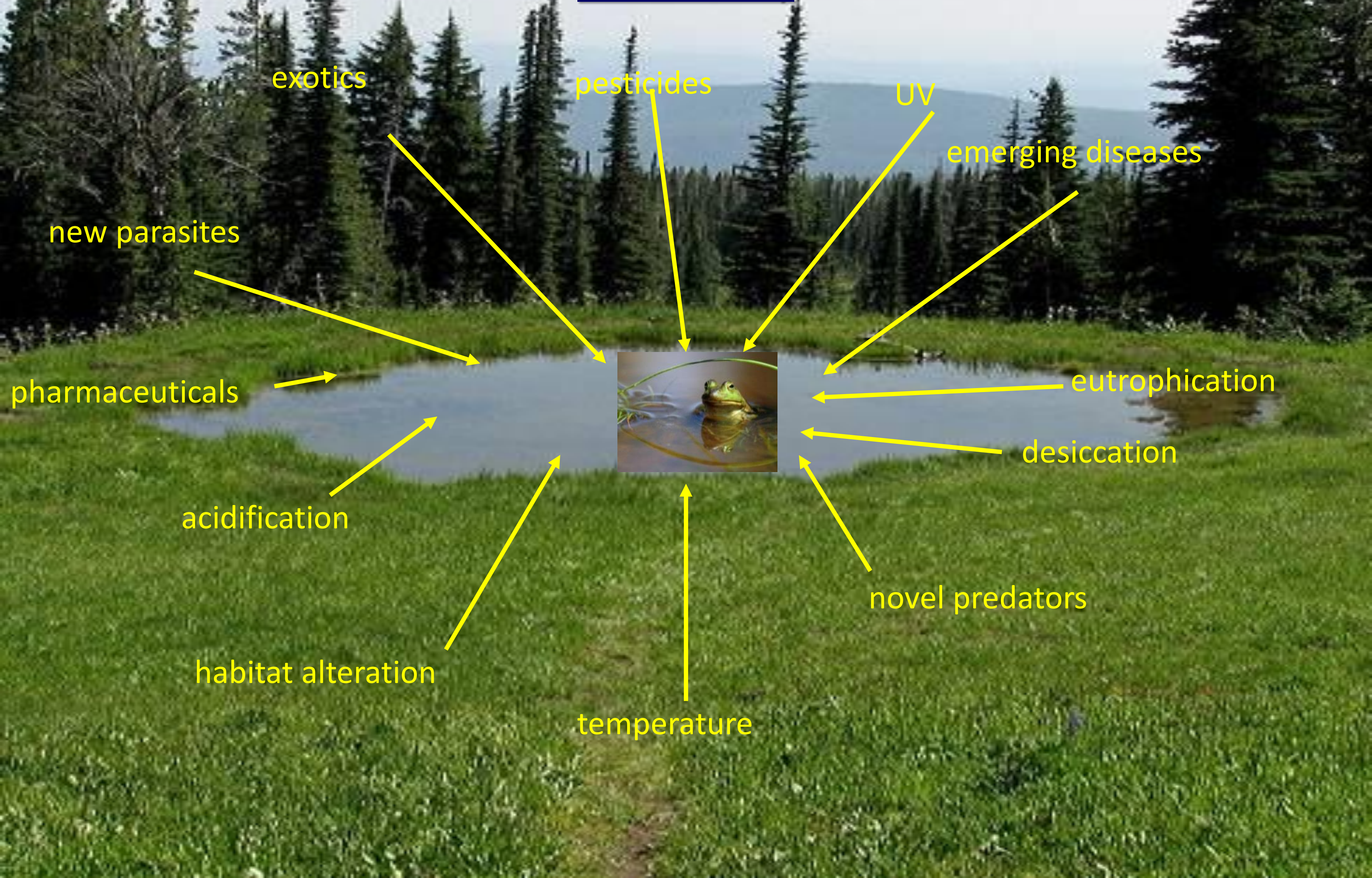
JULY 13, 1998 NEWSWEEK 67

Why are Amphibians Important?



- source of human medicine
- indicators of environmental health
- control insects and insect-borne diseases
- vital role in ecosystems
- role in culture/religion
- aesthetics

My Research Investigates the Causes & Implications of Amphibian Extinction Events & Causes for Loss in Biodiversity

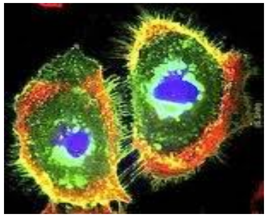


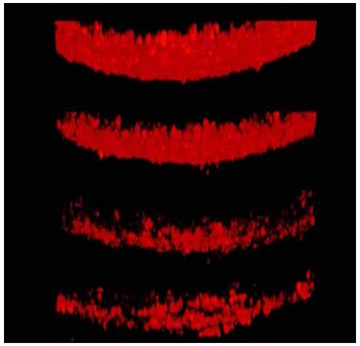
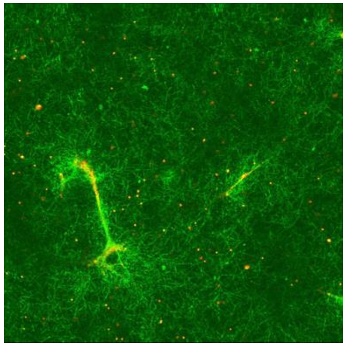
Research in the Cell Biophysics Lab

How multicellular systems self-organize by utilizing

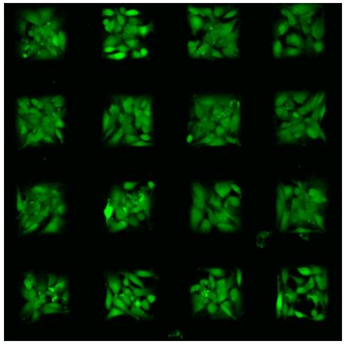
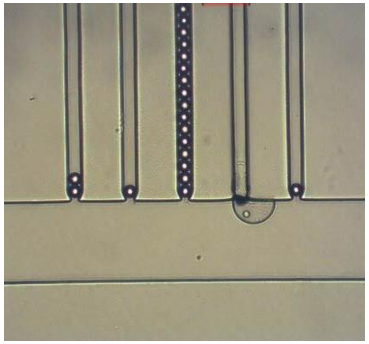
- mechanosignaling and
- chemosignaling

to communicate with each other

Caner cells can coordinate each other's pace during collective invasion into collagen gel – talking through force.

Fibroblast cells rearrange themselves into critical point – to optimize information propagation and sharing.

- ❑ Each direction has several sub-projects focusing on physics / material / biochemistry / computation.
- ❑ We constantly accommodate 6-7 undergraduate students and they out numbered graduate students and faculties!

Mathematics in Medical Imaging

David Finch, Dept of Mathematics

First generation

The cat scan.
The mathematics is the Radon transform.

$Rf(p,\omega) = \int f(p\omega + t\omega^{\perp})\, dt$

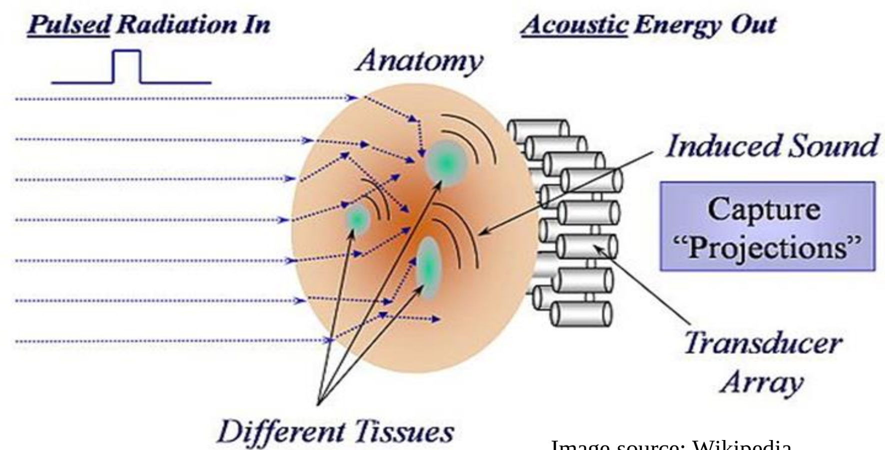


Image source: Wikipedia

What to do if the sound speed is not known?

Candidates should have:

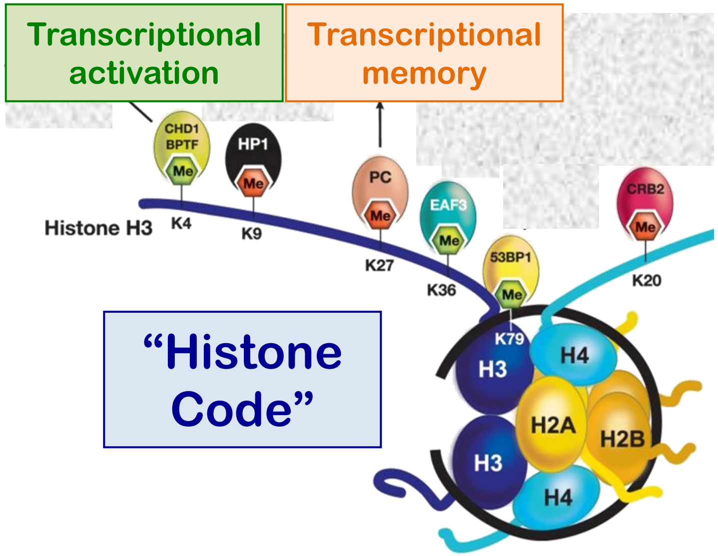
- Substantial math
- A year of physics
- Programming skills in Matlab or python

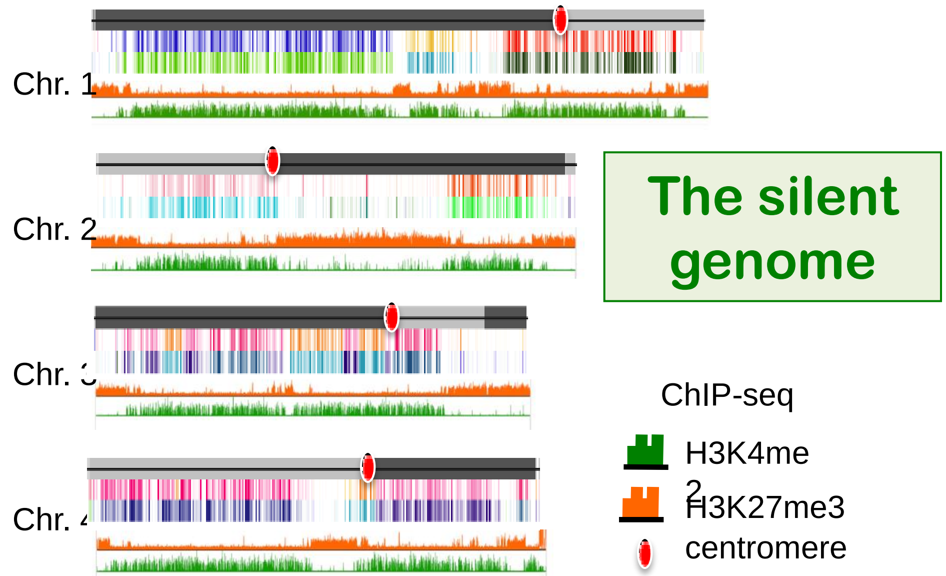
Thermoacoustic tomography: Send in RF, generate sound measured on the boundary.

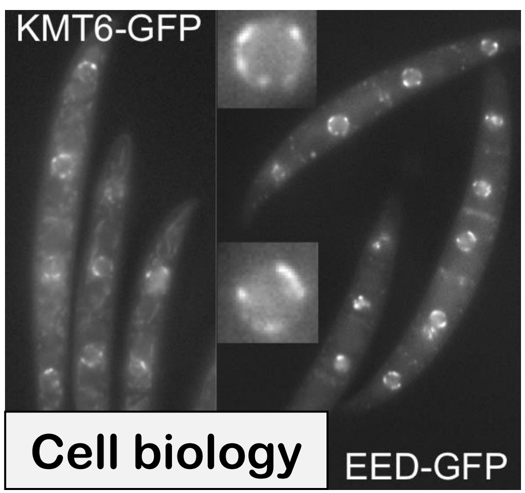
Solve the wave equation from boundary data back to initial data.

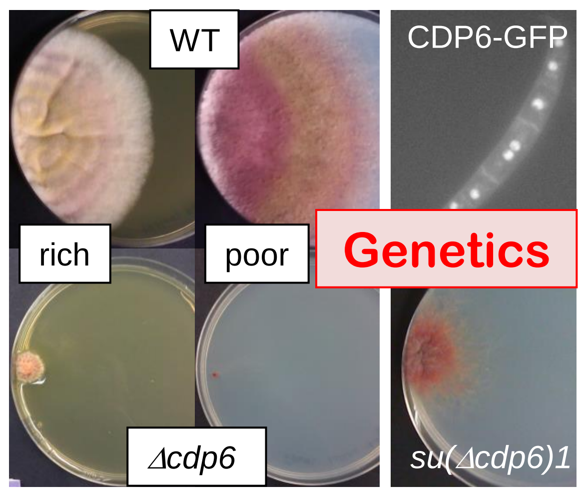
This requires knowing the sound speed.

Manipulating genomes to express natural products









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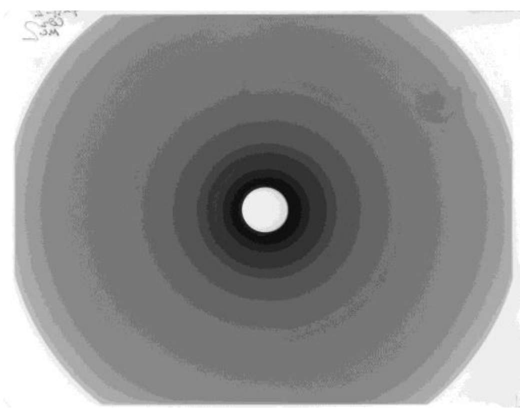

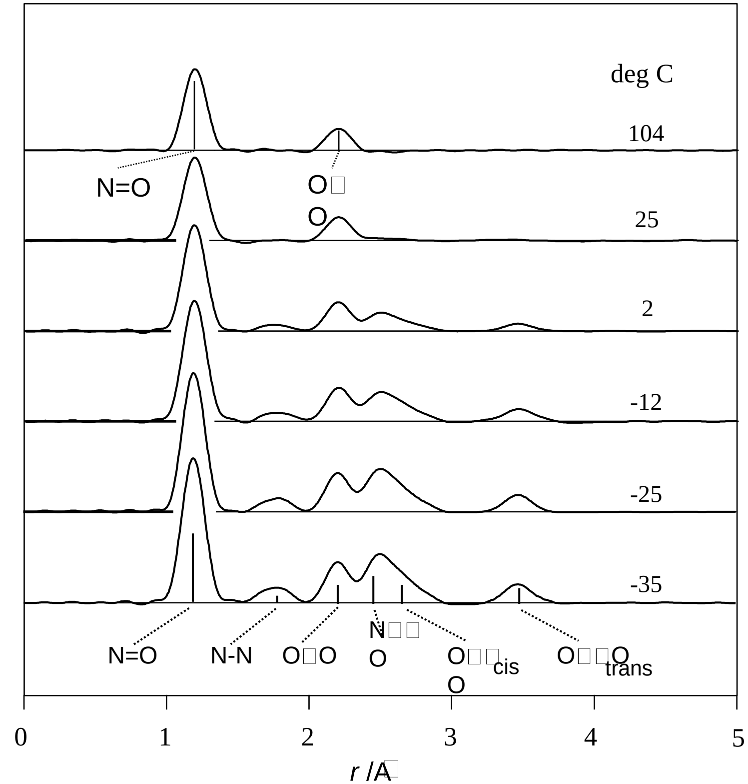

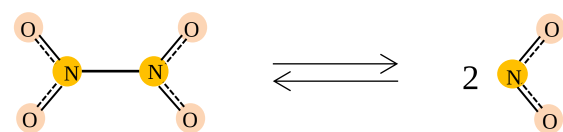

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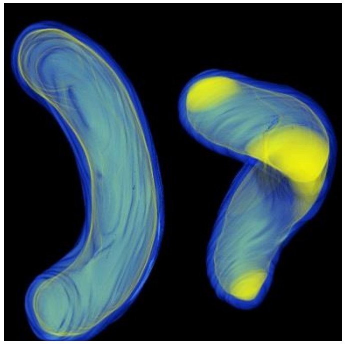
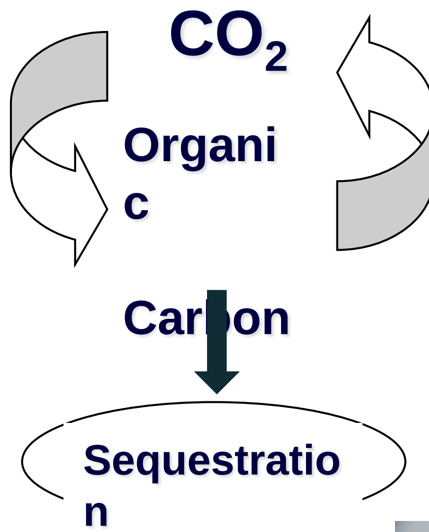
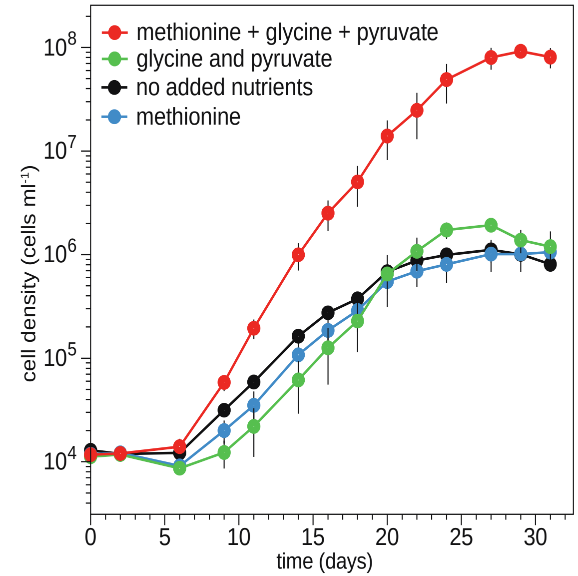
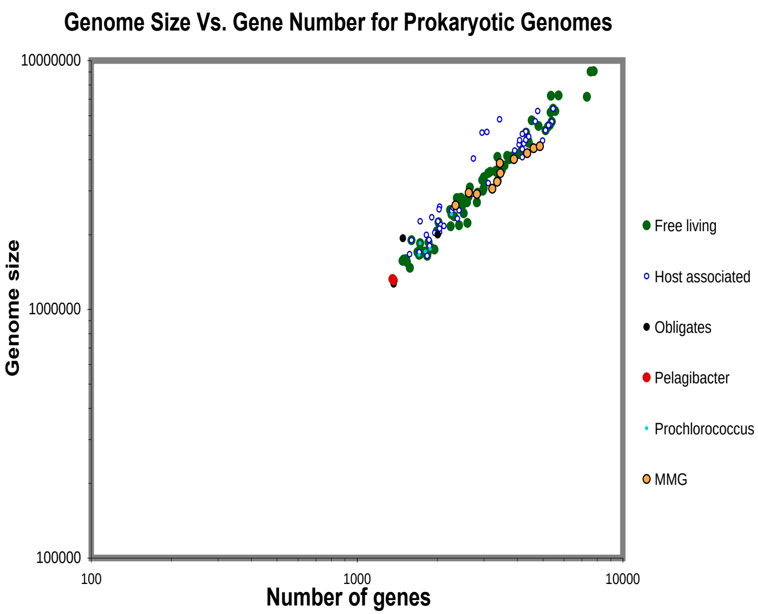
Outliers: Minimalism in Ocean Bacterioplankton

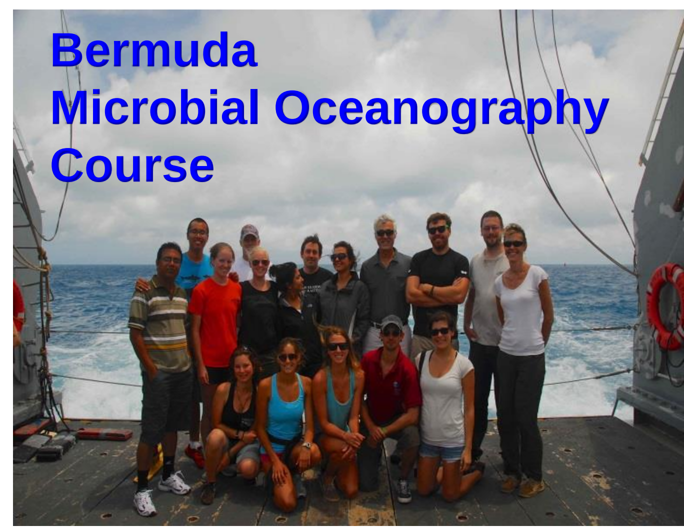
S Giovannoni
Department of Microbiology, Oregon State University









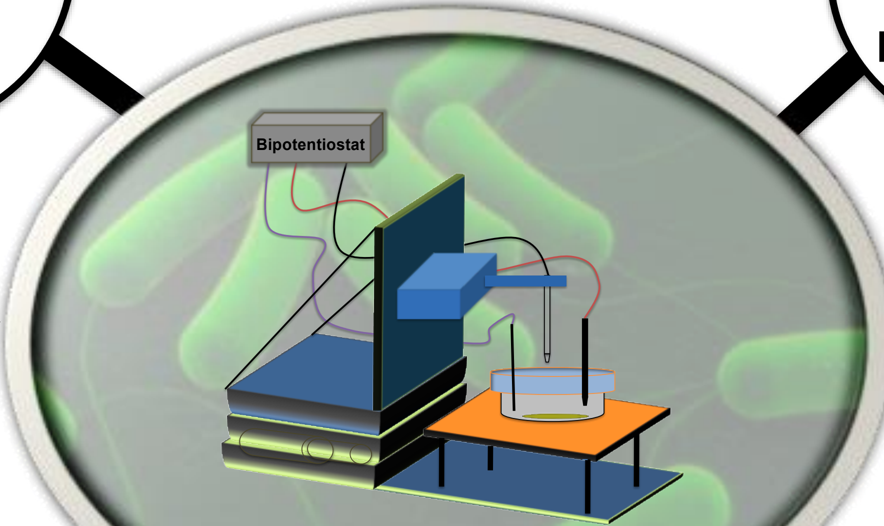


Developing New Electrochemical Techniques to Study Complex Biological Systems

Biomedical

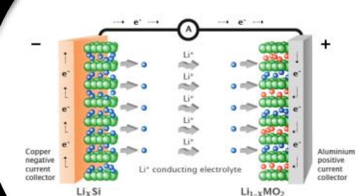
- Wound Healing
- Biofilm and Cancer
- Dental Biofilm
- Fundamental microbiology

Environmental



SECM

Microbiology



Energy

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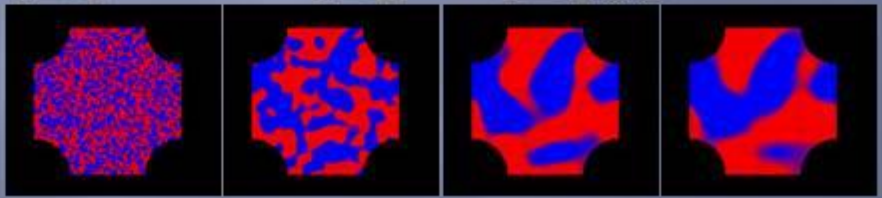
BIOFILMS and CRYSTALS: Mathematical & Computational Modeling

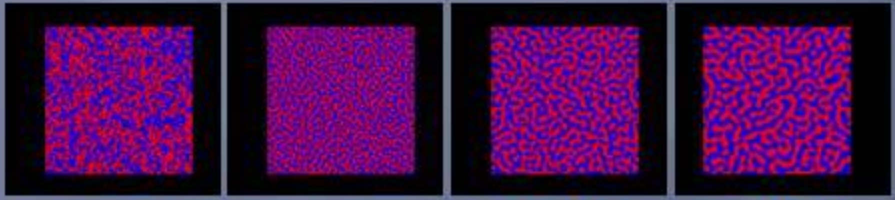
OBJECTIVES: one or more of

- *<u>Develop/modify</u> <u>models</u> for various stages of biofilm growth and pattern formation*
    - *use differential equations, or*
    - *use discrete modeling*
- *<u>Implement</u> models on a computer using MATLAB*
- *<u>Study</u> properties of the models and solutions*
- *Perform <u>simulations</u>*

<u>Ex.:</u> of two biofilm/crystal models:

t=0 t=2 t=100





CONTACT

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- ***Stipend possible for qualified students from NSF project "Hybrid modeling in porous media"***

Jaga Giebultowicz lab

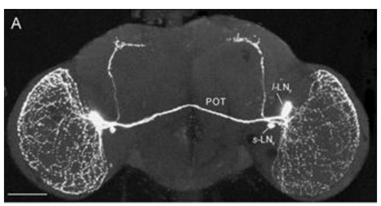
We study rhythms of life called **circadian rhythms**

All organisms have biological clock that generate circa 24 h rhythms

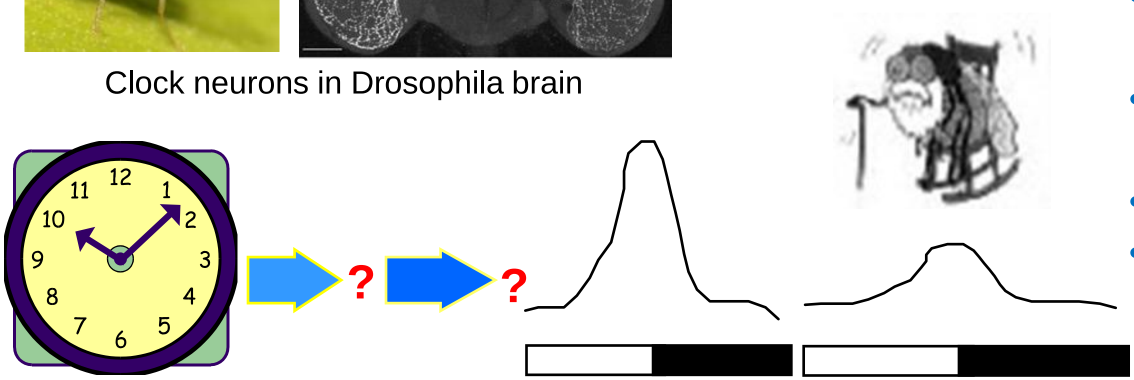
Animals are active at certain time of day or night

Humans have times of high and low alertness

Biological clocks regulate physiological and molecular rhythms: what if they are broken?



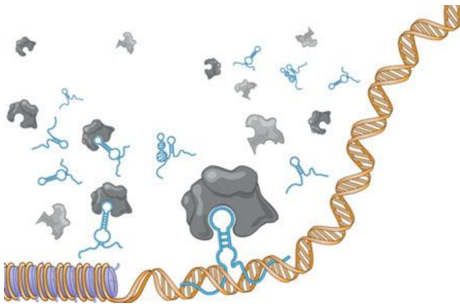
Clock neurons in Drosophila brain

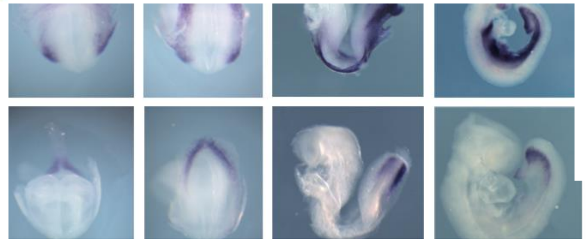


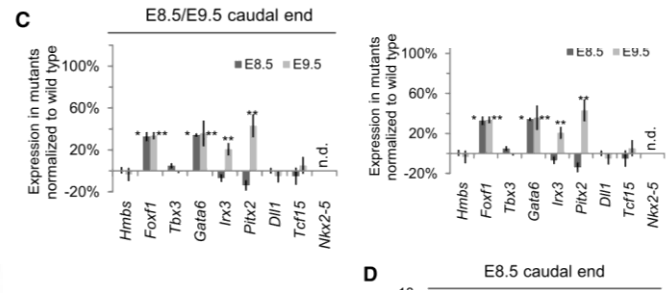
What you could study in our lab:

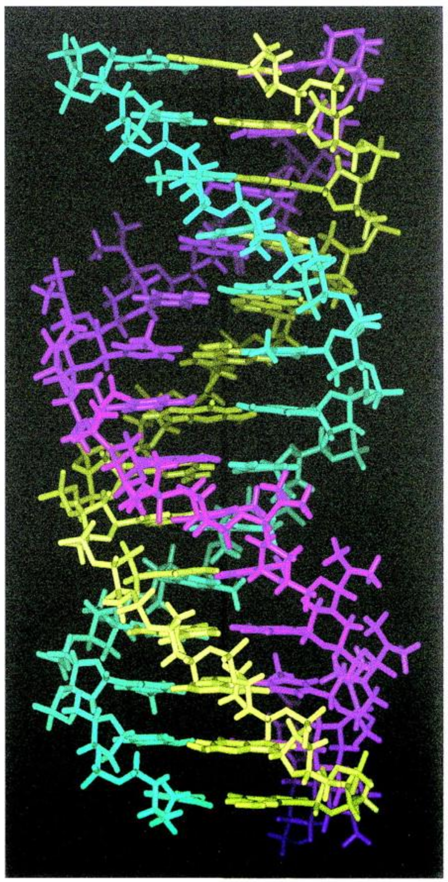
- Genome wide circadian gene expression
- How gene expression changes during aging?
- How to repair old biological clocks?
- Do strong clocks protect from aging?

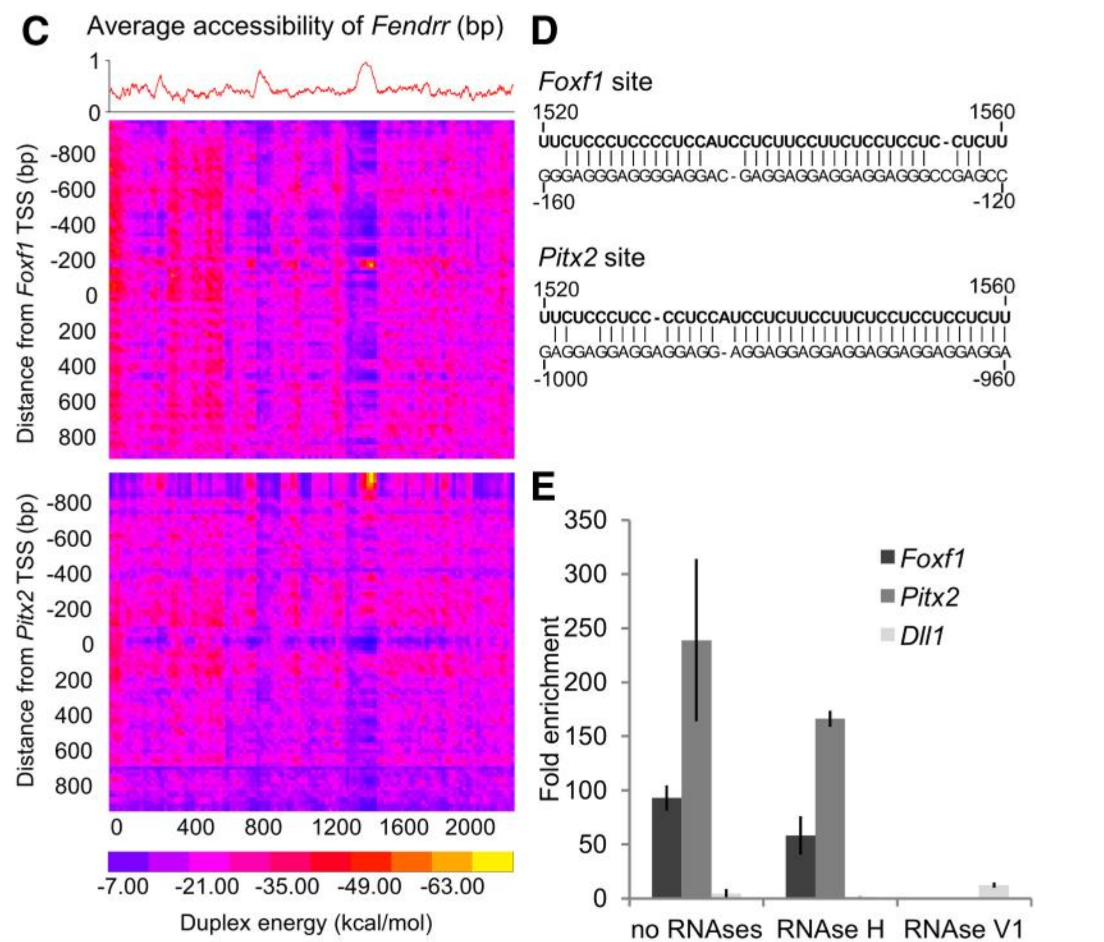
Hendrix Lab for Computational Biology of Noncoding RNAs



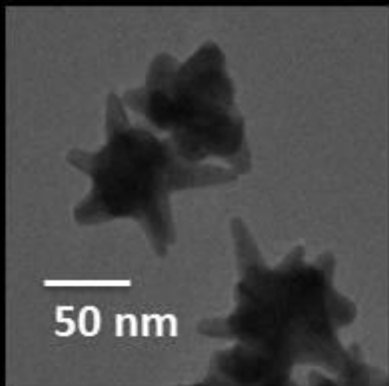




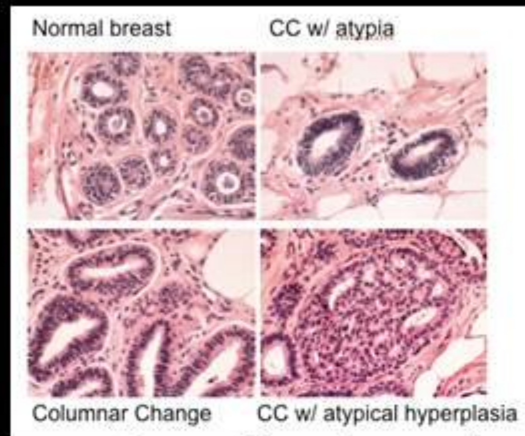




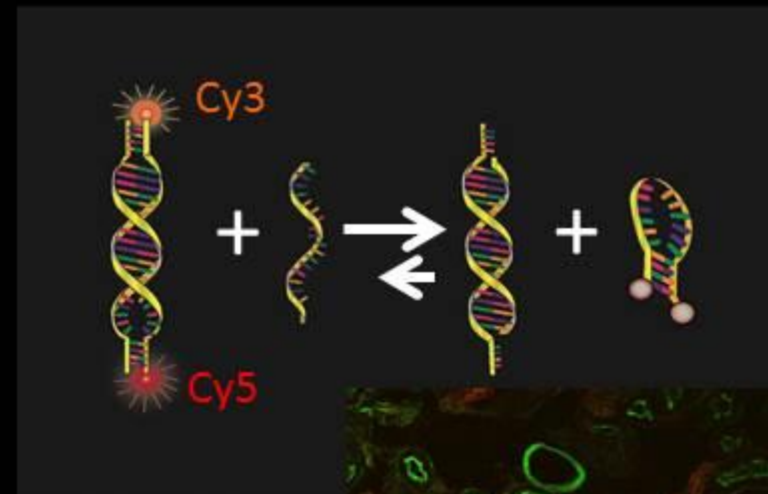
Burrows Group : *Development of laser technology and biosensors to study biomolecular regulation and the fate of a cell*



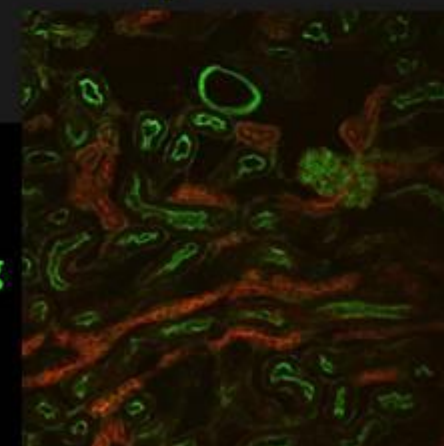
Nanomaterials
& Raman Scattering



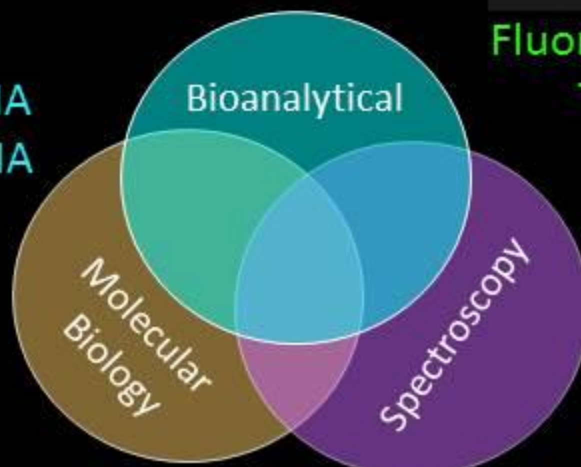
*Seewaldt and co-workers



Fluorescence
Tissue
Imaging



HOLY GRAIL: Discover a miRNA biomarker or a group of miRNA biomarkers of triple negative breast cancer



- **Honors** students have potential to **publish**
- **Honors** students have potential to collaborate with **interdisciplinary** group

Modeling Marine Protected Areas (MPA) - Resolving a Paradox?

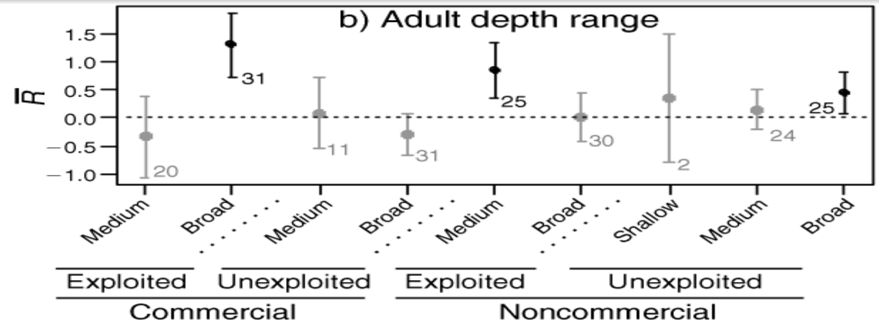
Enrique Thomann (Math) and Patrick De Leenheer (Math/Zoology)

MPA’s are tools for protection of population and natural habitat.

Empirical observations show an increase in relative abundance of protected species as a function of mobility of the individuals.

Objective: To develop simple mathematical model that captures this empirical observation.

x, y = population in MPA and fishing ground



Claudet et al: Ecological Applications 2010.

Model 1 does not capture this behavior.

Hypothesis: An asymmetric diffusive mixing might be enough to resolve this feature

Model 1: Diffusive mixing, d>0 constant.

r=growth rate of population in MPA

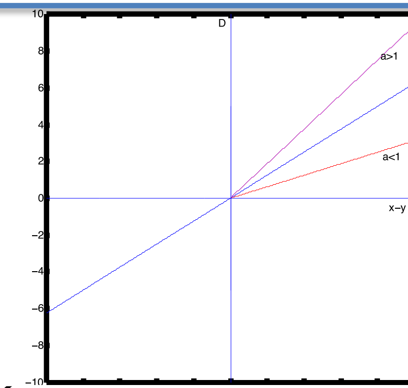
K=carrying capacity in MPA

r*, K* = corresponding parameters in fishing grounds, r* < r, K* < K.

$$\dot{x} = r\ x(1 - \frac{x}{K}) - d(x - y)$$

$$\dot{y} = r^* y(1 - \frac{y}{K^*}) + d(x - y)$$

$$D(x-y) = d(x-y)^+ - a\ d(y-x)^+$$



$$x^+ = \max(0, x)$$

$$\dot{x} = r\ x(1 - \frac{x}{K}) - D(x - y)$$

$$\dot{y} = r^* y(1 - \frac{y}{K^*}) + D(x - y)$$