

# **Presentation to the SRS Citizens Advisory Board**

## **SRS Strategic Initiative in Radioecology**

**October 30, 2012**

### **Initiative Champions**

**Dr. Karen Hooker     Dr. John Marra**

**Dr. Olin E. Rhodes, Jr.,**



**The University of Georgia**

Savannah River Ecology Laboratory

# OBJECTIVES

- ◎ **What is Radioecology?**
- ◎ **Why a Strategic Initiative?**
- ◎ **Why do we Need Radioecology?**
- ◎ **What are the Objectives?**
- ◎ **What is NCoRE?**
- ◎ **Recent Accomplishments**
- ◎ **Current Plans**
- ◎ **Future Directions**

# ◎ **What is Radioecology?**

- **Radioecology is the study of the fate and transport and potential effects of radionuclides and associated contaminants in the environment.**
- **In short, it is the science that describes the fundamental connection between environmental health (including health of biota) and human health risks.**

# ◎ **Why a Strategic Initiative?**

- **Long History of Radioecology Research on the SRS**



# History of Radioecology Research at SRS

## ◎ 1950's and 60's –

- Studies of the **effects of ionizing radiation** on plants and animals
- Use of radionuclides as **tracers for studies of basic ecological processes** such as food web dynamics, biogeochemistry, and behavioral and physiological processes of individual species

## ◎ 1970's and 80's –

- Studies of **fine-scale distribution and mobility** of radionuclides in contaminated environments
- Studies of **uptake and transport of radionuclides** in soils, water, vegetation, fish, and wildlife
- Studies of uptake and **health risks** of radionuclides in **agricultural ecosystems**

# History of Radioecology Research at SRS

## ◎ 1980's and 90's –

- Studies of the **transport and effects of radio-cesium** in long-lived species of plants and animals
- **Bioavailability** of radionuclides in aquatic sediments and **remediation** options for exposed sediments
- Effects of **radionuclide speciation** on contaminant transport
- **Genetic effects** of radionuclides in vertebrates
- Establishment of the **Par Pond radioecology laboratory** at the Savannah River Site
- Establishment of the **International Radioecology Laboratory at Chernobyl** in partnership with Ukraine, the US State Department, DOE, and SREL

# History of Radioecology Research at SRS

## ◎ 2000's –

- Over **200 scientific papers on radioecology** published by SRS scientists
- SRS has developed **radioecology databases** spanning more than 30 years
- SREL has established a one of a kind facility for the study of the effects of **low dose exposure** to radionuclides in aquatic organisms
- Studies have begun to focus on the **synergistic effects** of radionuclides with other environmental contaminants on the Savannah River Site

# ◎ **Why a Strategic Initiative?**

- **Long History of Radioecology Research on the SRS**
- **Unique Data Sets, Facilities, and Expertise on the SRS**

# Legacy of Data Collection Spanning 60 Years on the SRS

- ◎ **SREL** – Ecological Characterization; Environmental Impacts
- ◎ **SRNL** – Fate and Transport; Remediation and Mitigation
- ◎ **Dupont/Westinghouse/SRNS** – Long-term Environmental Monitoring; Biological Risk Assessment
- ◎ **USFS** – Natural Resource Inventory and Management

# SRS Radiological Studies Span Decades

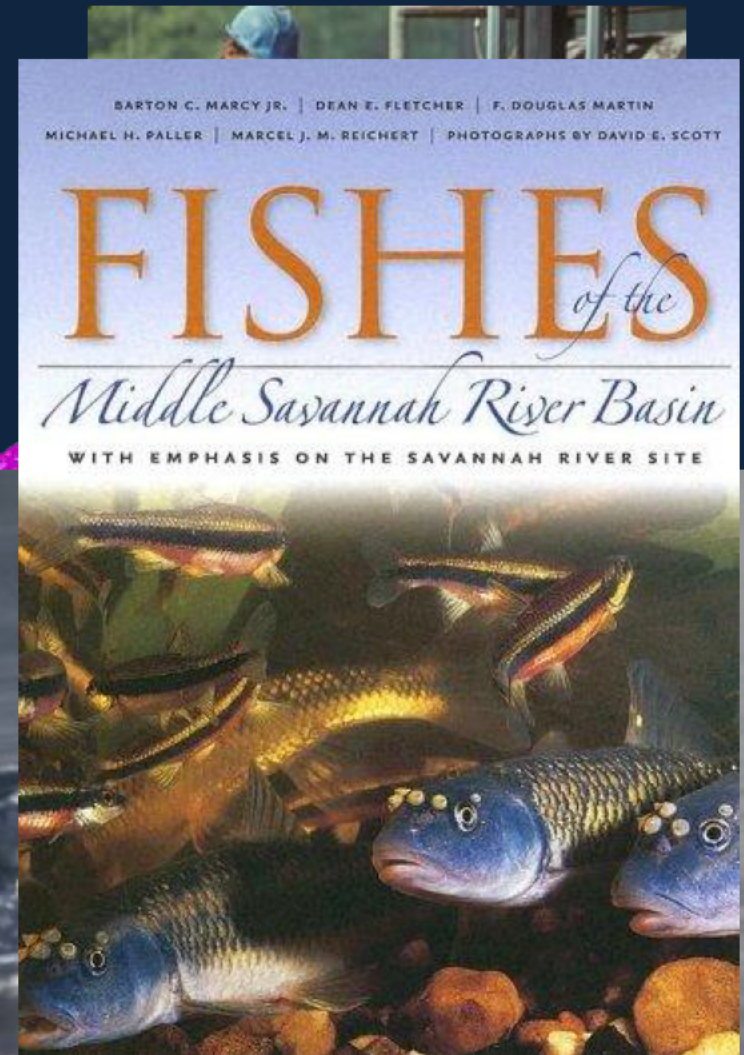
## Long-term Data Sets Include:

- **Environmental characterization**

- √ • Soil/Groundwater studies
- √ • Contaminant levels and distribution
  - Bay hydrology
- √ • GIS imagery/habitat maps

- **Ecological**

- √ • Amphibians and reptiles
- √ • Fish communities
- √ • Waterfowl
  - Deer
  - Furbearers
  - Plant communities



# ◎ **Why a Strategic Initiative?**

- **Long History of Radioecology Research on the SRS**
- **Unique Data Sets, Facilities, and Expertise on the SRS**
- **Loss of Educational Programs in Radioecology Worldwide**



- ◎ **Currently no Undergraduate Programs in Radioecology in US**
- ◎ **Only 1 Graduate Degree in Radioecology in the World**
- ◎ **Graduate Pipeline is Down to a Trickle**
- ◎ **Few Radioecologists Left in the US to Train New Generations**



# ◎ **Why a Strategic Initiative?**

- **Long History of Radioecology Research on the SRS**
- **Unique Data Sets, Facilities, and Expertise on the SRS**
- **Loss of Educational Programs in Radioecology Worldwide**
- **Need for Radioecology on SRS, in the US, and Internationally**

# Legacy Sites: P Reactor @ SRS



# Past and Future: Tritium @ SRS



# The Future: MOX @ SRS





# ◎ The World Needs Radioecology for Today and for Tomorrow



# ◎ Why a Strategic Initiative?

- As long as there is an interest in the areas below there is a need for a scientific field to provide *credible, consistent and defensible* information that can be used for clean up activities and conducting risk assessments:

- ◎ Nuclear industry (new facility start-ups, small modular reactors development and aging reactor and other nuclear facility closures)
- ◎ Uranium mining and milling
- ◎ Emergency response
- ◎ Radioactive waste management
- ◎ Environmental releases from nuclear facilities
- ◎ Naturally occurring radionuclides in non-nuclear industries
- ◎ Education of the public about radiological risks

# ◎ **Why Do We Need Radioecology?**

## ➤ Growing interest in Nuclear Power

- ◎ Over 430 commercial nuclear power reactors operating worldwide in 31 countries.
- ◎ 56 countries operative a total of 240 research reactors
- ◎ 180 nuclear reactors power ships and subs
- ◎ 8 countries with nuclear weapons
- ◎ 2 new commercial nuclear reactors under construction in Georgia

## ➤ Nuclear facilities

- ◎ Decommissioning of existing facilities
- ◎ Remediation of contaminated sites

# ◎ **Why Do We Need Radioecology?**

## ➤ **Aging Nuclear Reactors**

- ◎ US nuclear reactors were originally licensed to operate for 40-years. periods. Over half of US nuclear reactors are over 30 years old and have received 20-year extensions to their licensed lifetimes.

- ~20 aging reactors without funding to fully decommission the reactor will be left sitting idle until funds can be secured.

## ➤ **New Nuclear Reactors**

- ◎ Development and placement of small modular reactors

## ➤ **Naturally Occurring Radionuclides**

- ◎ Nuclear Fuel Cycle

- ◎ Mining

## ➤ **Nuclear Accidents and Terrorists Events**



# ◎ What are the Objectives?

- Rebuild US Expertise and Capacity in Radioecology Through:
  - ✓ Research
  - ✓ Education
  - ✓ Knowledge Transfer
- Expand the influence and contributions of NCoRE Nationally and Internationally
- **Make SRS the “Go To” place for expertise in Radioecology in the US**

# ◎ What is NCoRE?

- Savannah River National Laboratory took the lead to establish the **National Center for Radioecology** in an effort to maintain and grow the scientific discipline and expertise in the United States.



# ◎ What is NCoRE?

- In 2010, NCoRE Signed MOU/MOA's with 6 Universities and 2 International Organizations
- In 2011, NCoRE held an inaugural meeting with Key Partners



# ◎ What is NCoRE?

## ➤ What Does NCoRE Do for SRS ?

- ◎ Brings together SREL and SRNL expertise to form a seamless collaborative partnership to address emerging national and international radioecology needs in the nuclear field
- ◎ Creates a network of academic and national laboratory researchers to provide opportunities for attracting funding and executing research at SRS
- ◎ Leverages sixty years of history to provide research support for other Enterprise-SRS Strategic Initiatives
- ◎ Provides intellectual capital and reputation for SRS

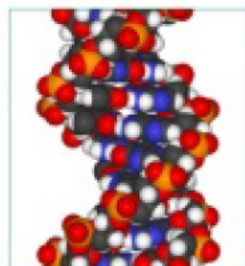
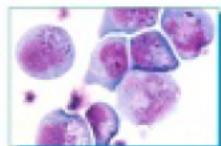
# NCoRE

National Center for Radioecology

Managed by Savannah River National Laboratory

## Molecular Studies

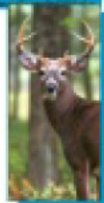
- Somatic Effects
- Germline Effects
- Molecular Dosimetry
- Proteomics
- Epigenetics



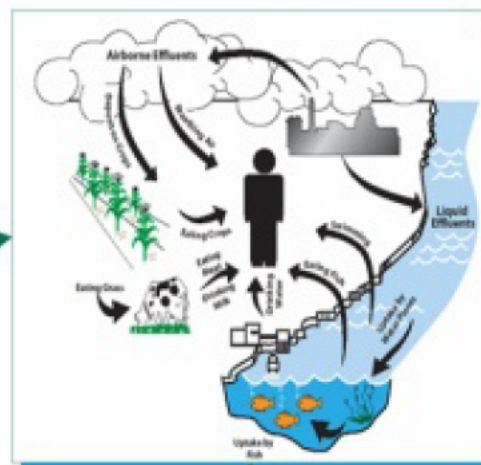
## Individual/Population Studies



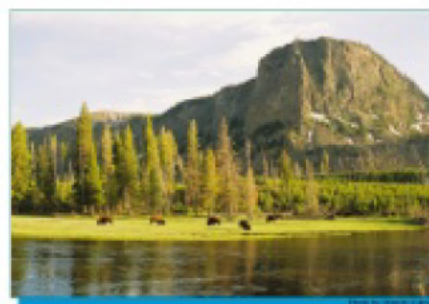
- Dose & Exposure Effects
- Extrapolation of Individual Effects to Populations
- Mixed Contaminants
- Validation of Models
- Food Pathways & Exposure



## Human Health



## Ecosystem Studies



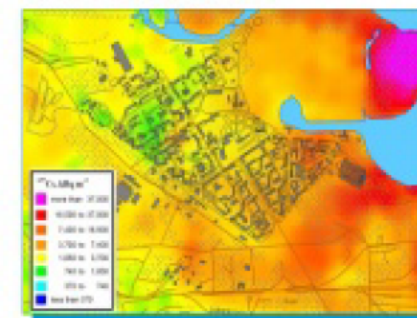
- Environmental Fate & Transport
- Risk Assessment
- Radioecology
- Terrestrial & Freshwater Systems
- Bioavailability

## Urban Radioecology / Homeland Security

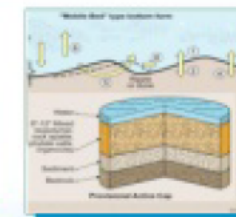
- Fate & Transport
- Accumulation Paths
- Distribution Vectors
- Homeland Security
- Risk Assessment
- Contaminant Dispersal
- Tracer Studies



Chernobyl Nuclear Power Plant 4<sup>th</sup> reactor



## Remediation and Sequestration



- Natural Attenuation
- Physical Methods
- Chemical Processes
- Extraction Processes
- Biological Processes
- Cleanup Cost Reduction

# ◎ **Recent Accomplishments**

- **International recognition of NCoRE as the US radioecology point of contact (IUR, StAR, ANSTO, IRL, IRSN)**
- **NCoRE web site established**
- **Held “Radioecology in the 21<sup>st</sup> Century” National Workshop at SRS (Aug. 15-16, 2012)**
- **SRNL meeting with DOE-HQ SC-1**
- **Hosting 1 masters and 1 Doctoral student and a graduate student summer intern in radioecology at SRNL**
- **SREL funded by Nuclear Regulatory Commission to teach 5 Maymester courses in Radioecology**



# ◎ **Ongoing Efforts**

## ➤ **Education**

- ◎ **Undergraduate Education**
- ◎ **Undergraduate Research**
- ◎ **Graduate Research**

## ➤ **Research**

- ◎ **Environmental Monitoring**
- ◎ **Low Dose Research**
- ◎ **Nuclear Forensics**

## ➤ **Knowledge Transfer**

- ◎ **Public Presentations**
- ◎ **White Papers**

# **New Maymester Courses in Radioecology Beginning in May 2013**

- ◎ **Have Developed Regional Environmental Radiation Protection Curriculum @ SREL**

## **Offers Coursework in:**

- **Radiation Safety and Protection**
- **Radioecology**
- **Radiation Genotoxicology**
- **Environmental Geochemistry of Radionuclides**
- **Radioecology Career Development Seminar**



## **SREL-USC Aiken Radioecology Minor**

- SREL is currently discussing the potential of developing a radioecology minor at USC-Aiken
- Such a minor would involve coursework at USC-Aiken, participation in Maymester Courses at SREL, and a structured internship at the SRS
- Collaborating partners include:
  - **SREL, USC-Aiken, SRNL, SCUREF & DOE**

# Undergraduate Internships for 2013

- It is anticipated that SREL/SRNL will recruit 4-8 new undergraduate interns for the Summer of 2013
- Most of these students will be working in the area of Radioecology



# Enhance Graduate Training Using SRS as a Living Laboratory





# Graduate Recruitment for 2013

- It is anticipated that SREL/SNRL will recruit 12-16 new graduate students in the Spring and/or Summer/Fall of 2013
- These students will be working in the areas of
  - ◎ **Radioecology (~7-8)**
  - ◎ **Toxicology (~2-3)**
  - ◎ **Restoration Ecology (~2-3)**
  - ◎ **Conservation Biology (~1-2)**

# ◎ Ongoing Efforts

## ➤ Research Priorities

- ◎ Role of radionuclides in the environment (transport and movement)
- ◎ Impacts those radionuclides have alone and in concert with other radionuclides and contaminants such as metals and organic chemicals
- ◎ Improve human and environmental protection by understanding environmentally relevant low dose exposures and radiation effects (external exposures and internal contamination, observations at population, community and ecosystem level and more species biodiversity)

# ◎ **Future Directions**

- **Low Dose Research**
- **State of the Art Surveillance and Monitoring**
- **Ecosystem Level Studies**
- **Nuclear Forensics**

# SREL's Low Dose Irradiation Facility (LoDIF)





# LoDIF

- **40** mesocosms
- **8** pads of **5** mesocosms
- Each pad has
  - **2** controls
  - **1** -  $\sim 2\text{mGy/day}$
  - **1** -  $\sim 20\text{mGy/day}$
  - **1** -  $\sim 200\text{mGy/day}$
- **3-4** buckets/mesocosm





# Types of Studies

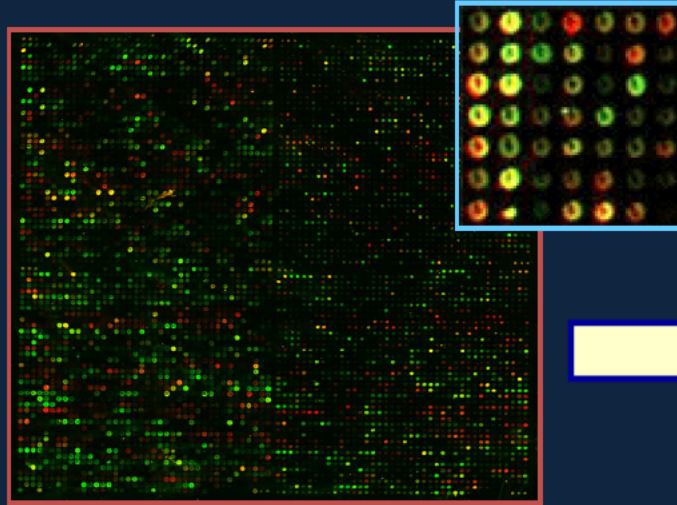
- Chronic exposure to low dose rads
- Chronic exposure to mixed waste
- Effects on:
  - Life history
  - Mutation rates
  - Development
  - Genomic instability
  - Population genetics



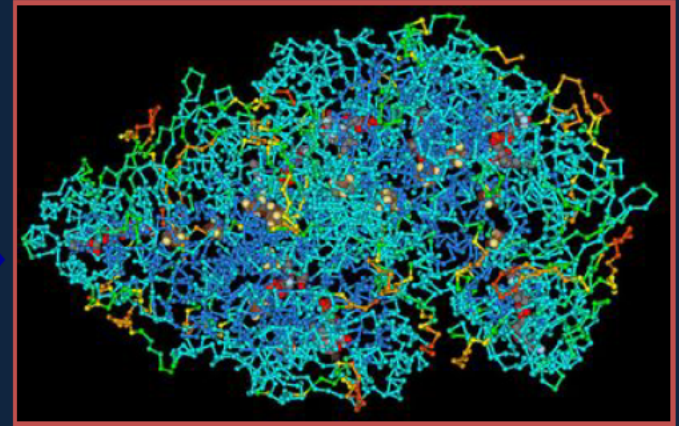
# Long-term Surveillance and Monitoring R&D



DNA molecule



DNA micro array



protein

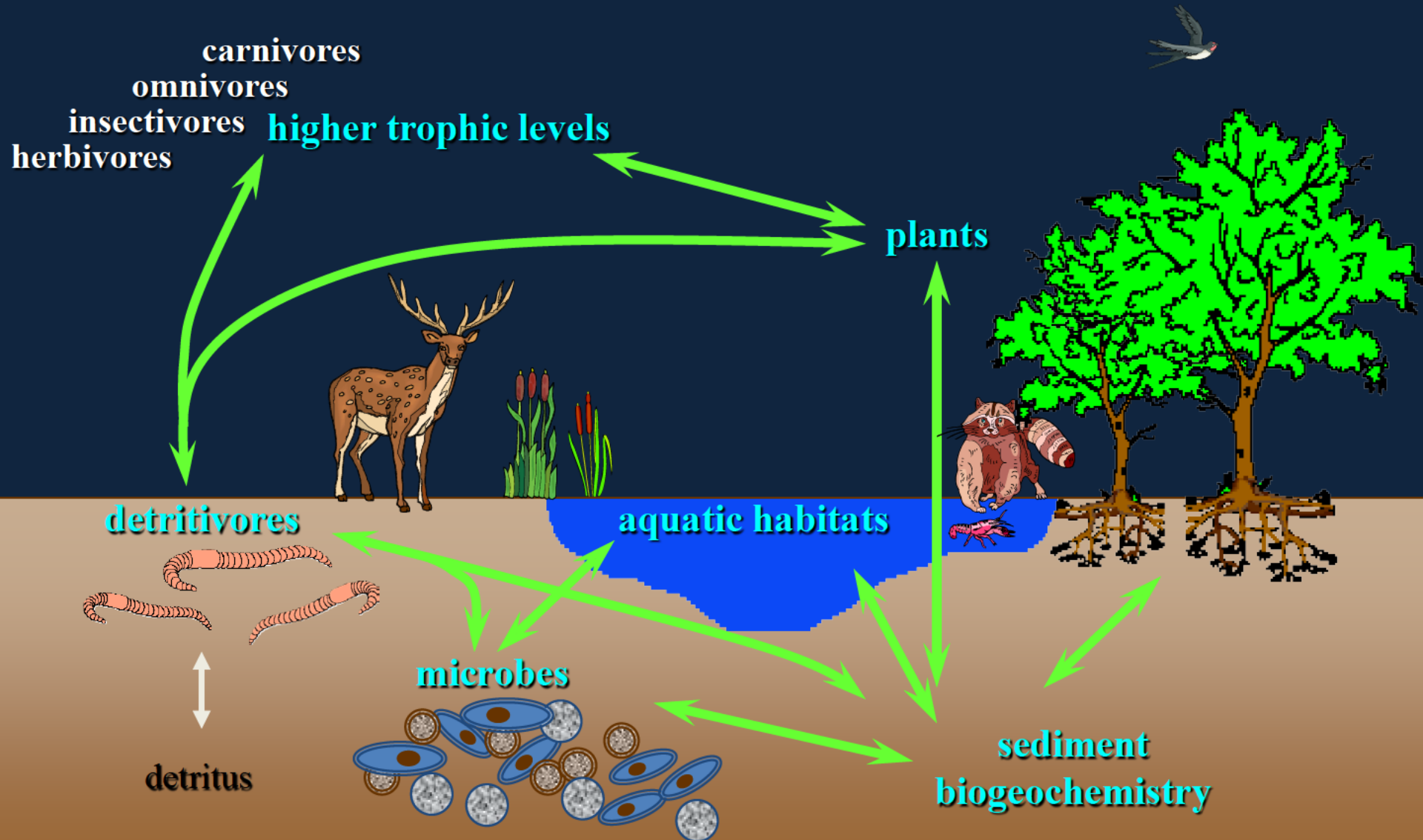


organisms



ecosystem

# Ecosystem Level Approaches





# Strategic Initiative Team

## SRNS-SRNL

- Co-Champion – John Marra
- Team Lead – Jack Mayer
- Alice Murray
- Wendy Kuhne
- Tim Jannik
- Eduardo Farfan
- Anna Knox

## DOE-SR

- Co-Champion – Karen Hooker
- Team Lead – Patrick Jackson
- Gail Whitney
- Tony Towns
- Dennis Ryan
- Jean Stump

## UGA-SREL

- Co-Champion – Gene Rhodes
- Stacey Lance
- John Seaman
- Jim Beasley
- J Vaun McArthur



**THANK YOU**