National Microbiome Initiative

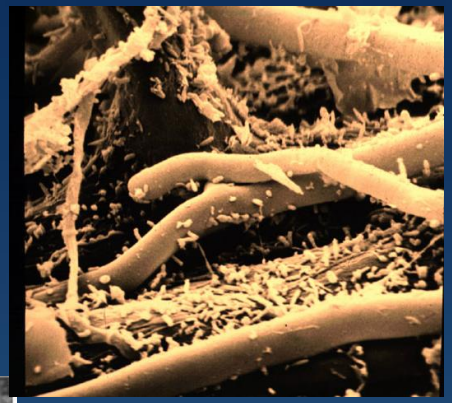
May 30, 2016

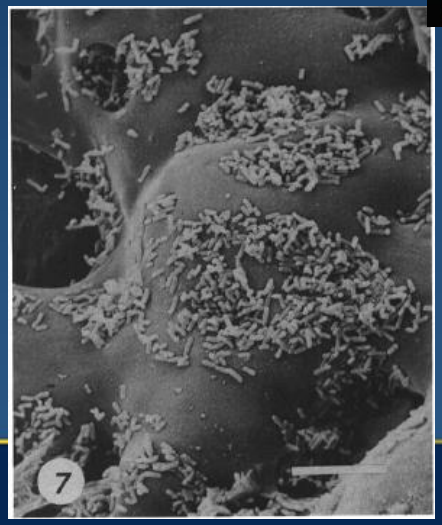
Jo Handelsman
Associate Director for Science
White House
Office of Science and Technology Policy

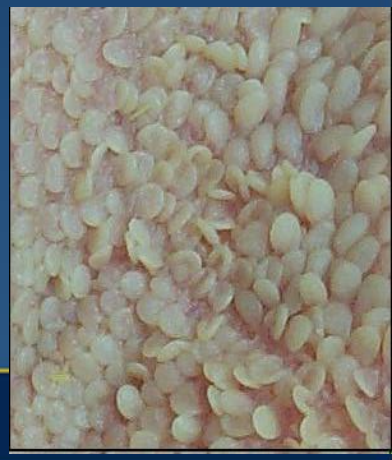
Microbiome – the collection of microorganisms associated with a particular habitat

Microbiome – the collection of microorganisms associated with a particular habitat

VIRTUALLY EVERY HABITAT ON EARTH







The National Microbiome Initiative

Topics

- Origins of the National Microbiome Initiative
- Goals of the Initiative
- Commitments
- Challenges and Policy

The National Microbiome Initiative

Obama Administration Priorities

- Applications needed for President's priorities

  Precision medicine
  Energy
  Agriculture
  Climate change

- Economic growth

  Private-sector investments in the microbiome have surged

The National Microbiome Initiative

Fact finding

OSTP

- Convened 12 Federal departments and agencies
- Convened several groups of scientists
- Issued request for information in Federal Register

The National Microbiome Initiative

Cross-cutting Themes Emerged

Common questions across biological systems

- What is a healthy microbiome?
- What is the nature of a robustness?

Technology needed to

- Detect, measure, and model in multi-dimensions the chemical currency of microbial communities
- Develop computational tools to analyze vast datasets
- Model community behavior

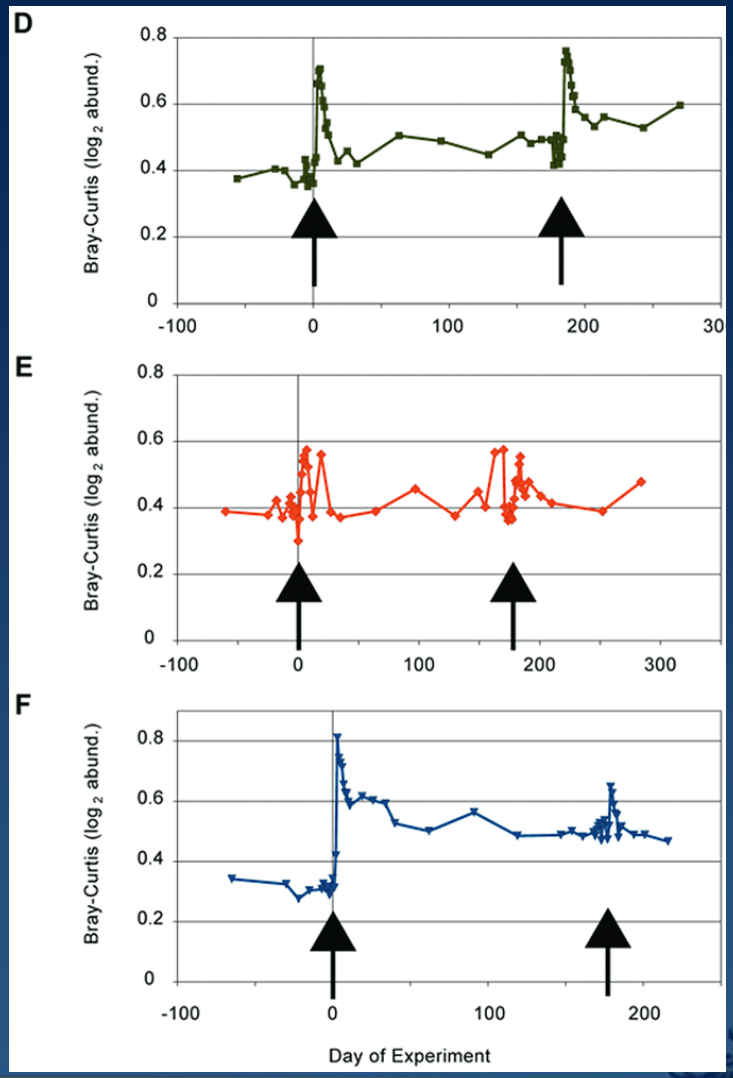
Applications

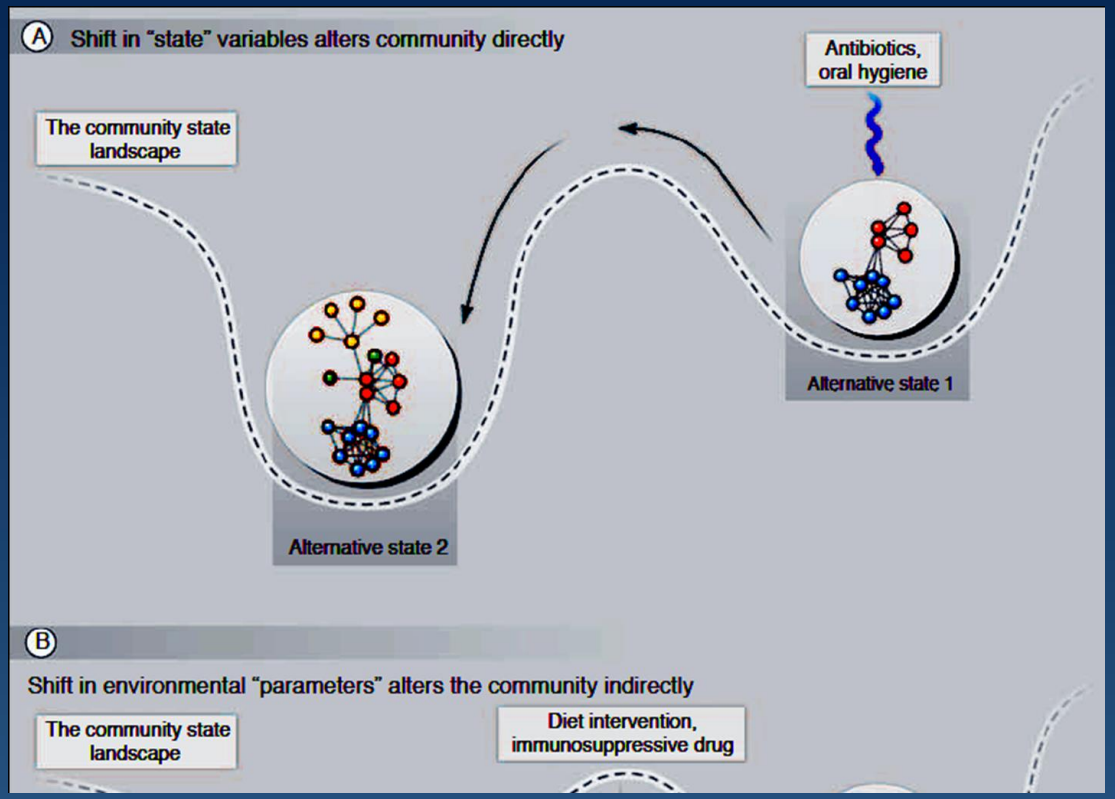
- Alter microbiomes predictably and reliably

Parallels Among Microbiomes

Examples

Gut Microbiome Behavior After Antibiotics





Relman, D. Nutr Rev. 2012 70:S2–S9.

Gulf of Mexico Microbiome After Oil Spill

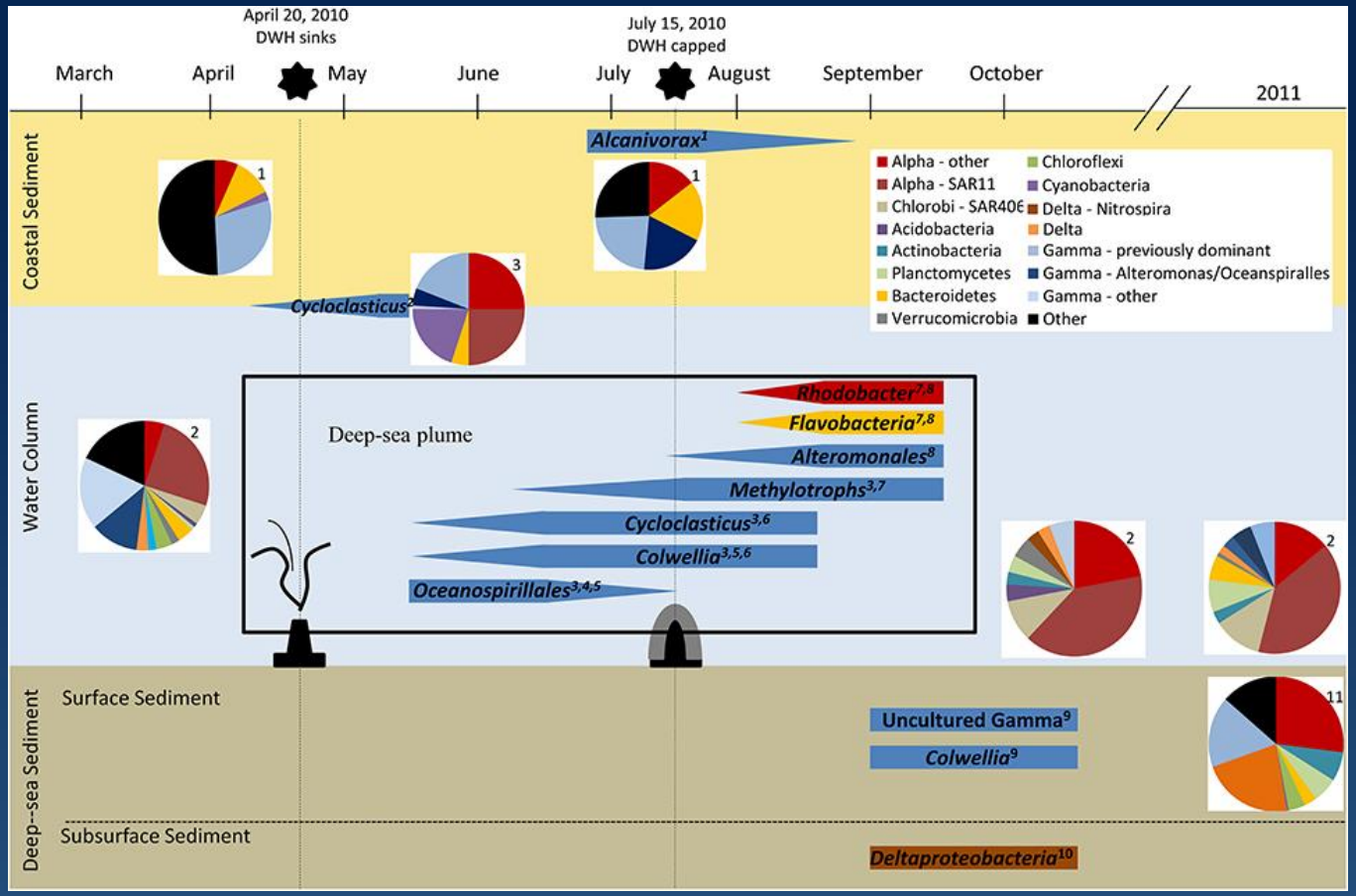
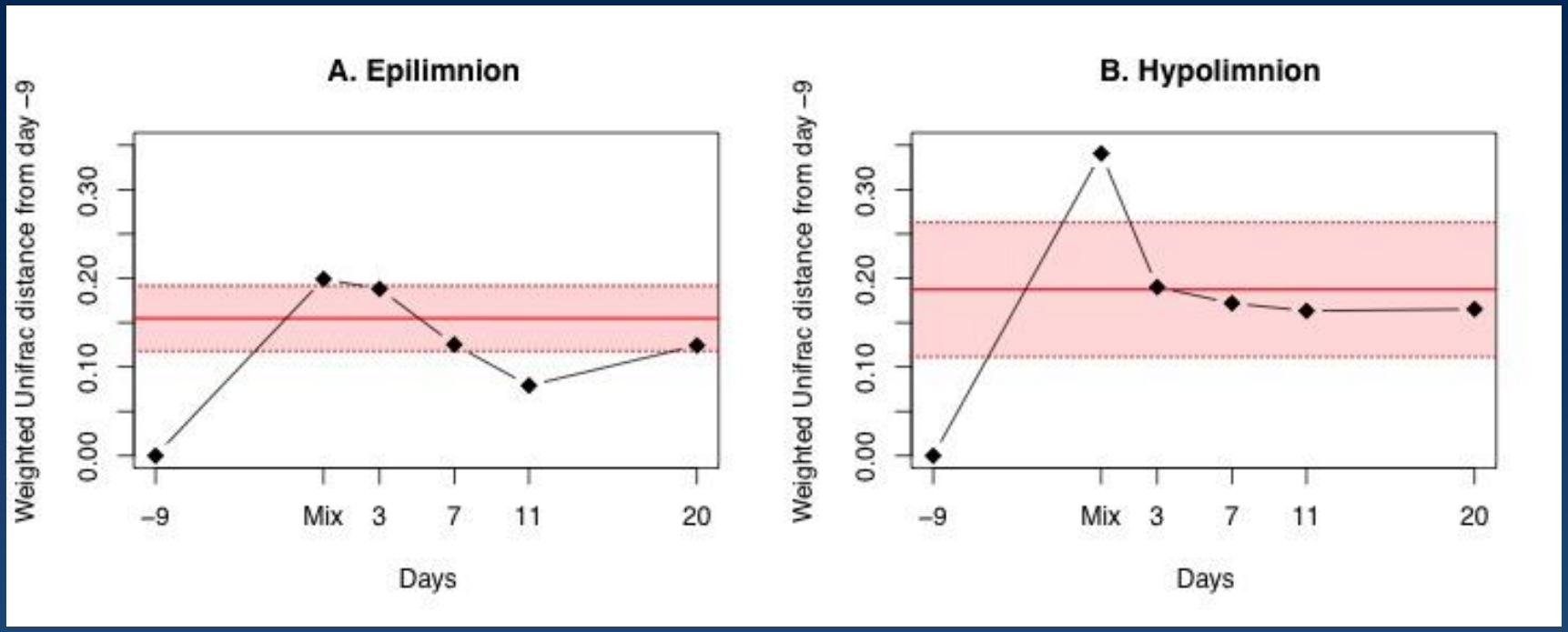


Figure 2. Overview of microbial response to the DWH oil spill. Data from numerous studies following the DWH oil spill are represented in this schematic using approximations from the published data referenced. 1, Kostka et al., 2011; 2, Yang et al., in press; 3, Redmond and Valentine, 2012; 4, Hazen et al., 2010; 5, Mason et al., 2012; 6, Valentine et al., 2010; 7, Kessler et al., 2011b; 8, Dubinsky et al., 2013; 9, Mason et al., 2014b; 10, Kimes et al., 2013; 11, Liu and Liu, 2013.

Lake Microbiome After Mixing Disturbance



Weighted UniFrac distances between each July time point and the day before the mixing manipulation began, day -9. **(a)** Epilimnion (0 m) UniFrac distances. **(b)** Hypolimnion (4 m) UniFrac distances. The red line is the overall mean UniFrac distance for all possible epilimnion or hypolimnion July pairs. The dotted lines and red shading show one standard deviation from the overall mean. Pyrosequencing data were used for this analysis.

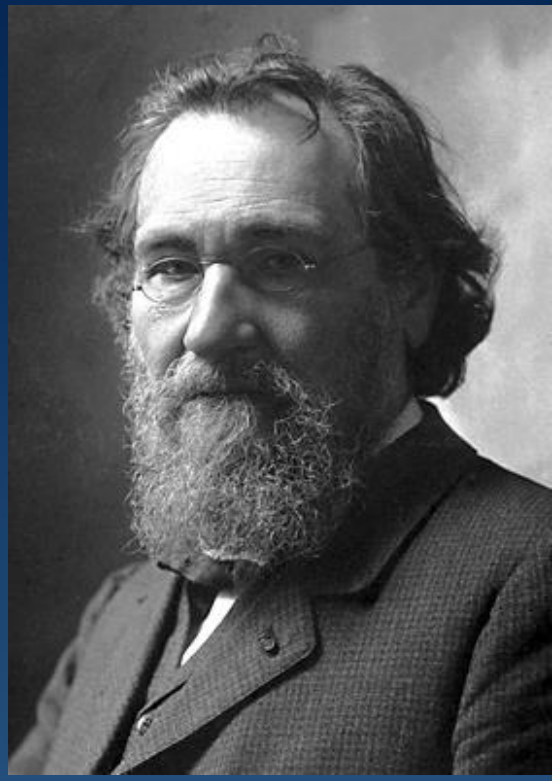
To harness microbiomes, we need to

Alter microbiomes predictably and reliably

Understand robustness

Attempting to change microbiomes is not new

- Mechnikov consumed liters of yogurt containing *Lactobacillus* each day
- *Lactobacillus* disappeared from his microbiome upon cessation of yogurt consumption
- **Many microbiomes are resistant to and recover from change**



Ilya Ilyich Mechnikov
~1900

The National Microbiome Initiative
Goals of the Initiative

- Interdisciplinary research on fundamental questions about diverse microbiomes.
- Platform technologies for probing and changing microbiomes and data access.
- New workforce through citizen science, public engagement, and educational opportunities.

The National Microbiome Initiative
Commitments

- U.S. Government invested more than **$900 million** over 2012-2014 in microbiome research

New Investments

- **$120 million** of U.S. Government-supported research
- **$400 million** in new commitments from non-Government groups

Examples of Non-Governmental Commitments

- **Themes:**
  - **Comparison across microbiomes**
  - **Universal tools to study microbiomes**

- Universities will develop microbiome centers

- Foundations will support new research programs
  - Gates $100 million for human and agricultural microbiomes
  - Simons — $XX for tropical forest studies
  - Moore — $XX for ocean microbiome

- Private sector will initiate new research programs

Predicted Outcomes of National Microbiome Initiative

- Unifying ecological principles
- Tools to probe microbiomes — microscopic and chemical profiles
- Tools to change microbiomes
- Products for humans, animals, agriculture, and environmental quality

Policy Challenges for Human Microbiome

- Fecal transplants — safety? consistent performance?
- Probiotics — labeling, quality control, claims
- Drugs —
  - –targeting microbiome with drugs
  - –non-target effects of all drugs on microbiome
- Prebiotics
- Diet
- How to unite microbiome research to reveal universal ecological principles?

International Collaboration on Microbiome

- How can our governments collaborate to maximize benefit from microbiome research?
- Are there adequate mechanisms for our scientists to collaborate internationally?

The National Microbiome Initiative