Wood Waste Utilization Workshop
June 28, 2006

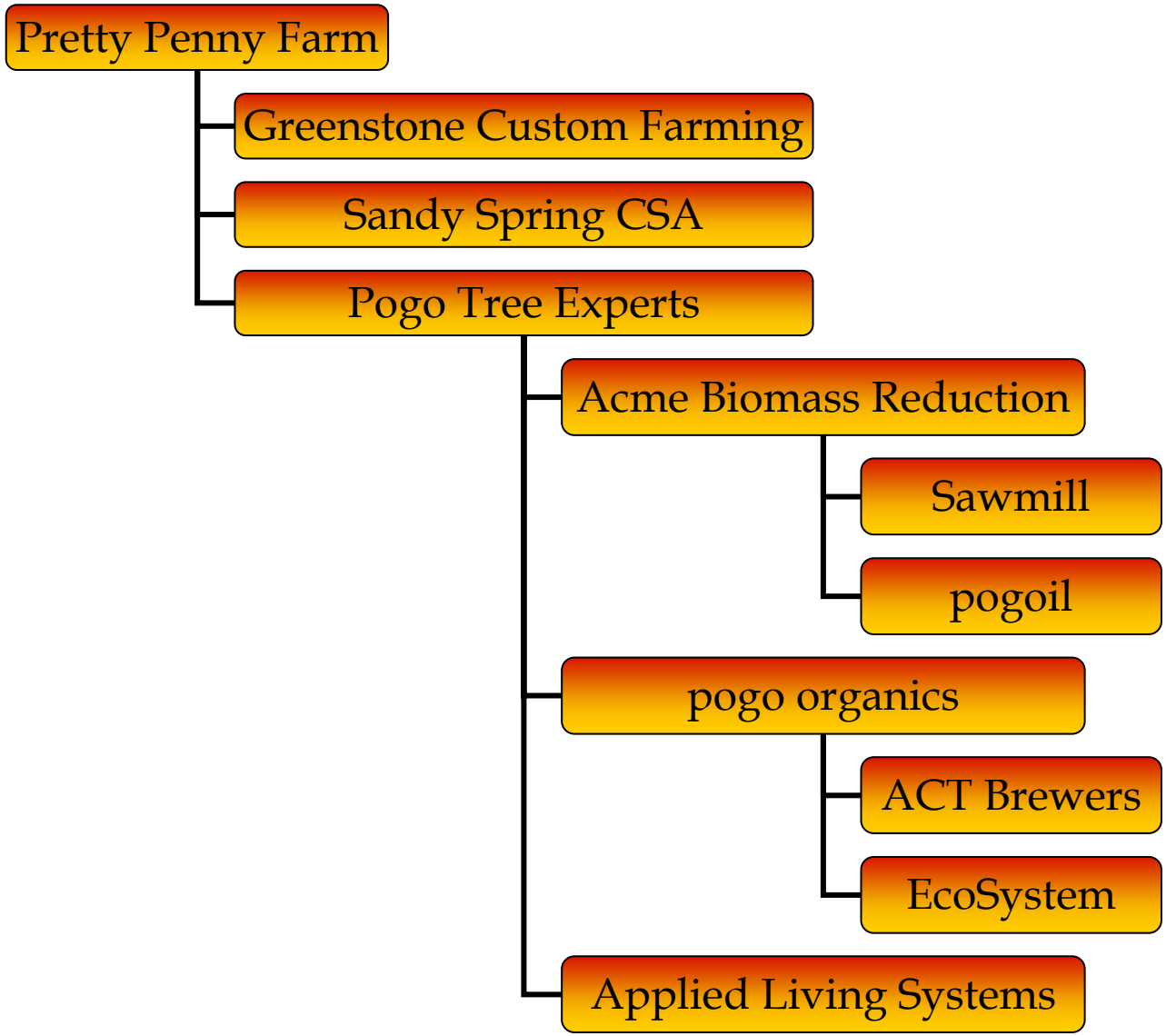
Metropolitan Washington Council of Governments

Pretty Penny Farm

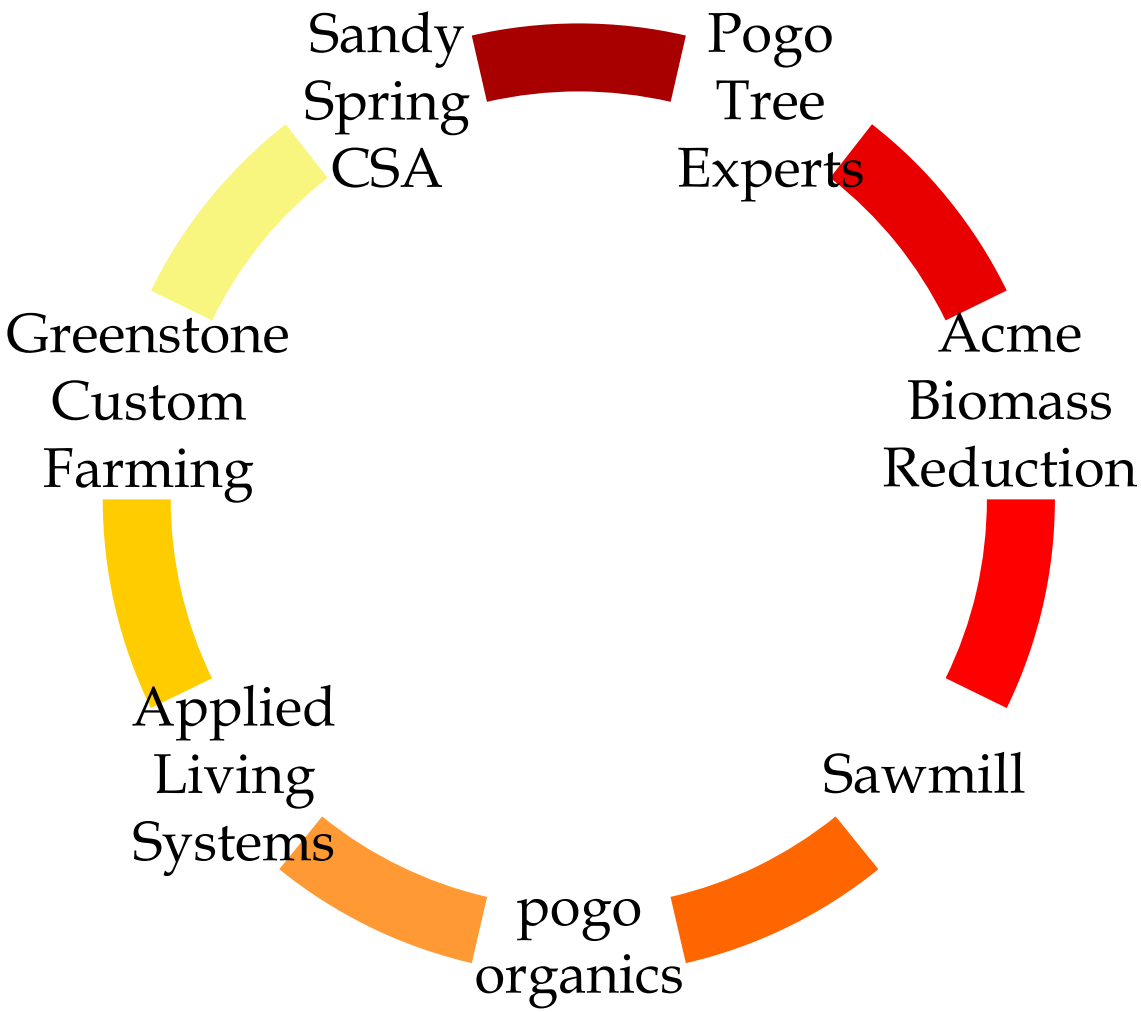
Pretty Penny Farm

1970	Greenstone Custom Farming	•Food Production
2000	Pogo Tree Experts	•Tree Preservation Service •Tree Restoration Service •Tree Removal Service
	Acme Biomass Reduction	•Waste Wood Processing Service •Mulch & Compost Production
	Sawmill	•Lumber Production
2004	pogo organics Aerated Compost Tea Brewers	•Compost Tea Production • ACT Production Equipment
2005	Pogooil Pogo organics Applied Living Systems	•BioDiesel Production •"EcoSystem" Production • EcoRestoration Service
2006	Sandy Spring CSA	•Food Production

Pretty Penny Farm



Pretty Penny Farm



Greenstone Custom Farming

- *Todd Greenstone*
- *(301) 774-6289*
- *Corn*
- *Hay*
- *Rye*
- *Soybeans*
- *Chickens*
- *Steer*

Pretty Penny Farm

Pogo Tree Experts

- Tree Preservation
- Tree Restoration
- Tree Removals

MD Tree Expert License #520
17328 Georgia Avenue
Olney, MD 20832
(301) 774-2968

Pogo Tree Experts

- MD Licensed Arborists mainly servicing Montgomery County and Washington D.C.

Pogo Tree Experts

- Tree Preservation
  - Forest Stand Delineation
  - Forest Conservation Plan
  - Tree Radar
    - Trunk Scan
    - Limb Scan
    - Root Scan
  - Silt Fence
    - Silt Fence
    - Super Silt Fence

Pogo Tree Experts

- Tree Restoration
  - Vertical Mulching/Aeration
    - Auger
    - Air Spade
  - Radial Trenching
    - Air Spade
  - Soil Invigoration
    - Air Spade
    - Blower Truck
  - Soil Fracturing
    - Grow Gun
  - Root Pruning
    - Root Pruner

Pogo Tree Experts


Pogo Tree Experts

Pogo Tree Experts

- Tree Removal
  - Tree Pruning
  - Tree Removal
  - Tree Chipping
  - Stump Grinding
  - Lot Clearing
  - Log & Brush Removal
  - Hauling

Pogo Tree Experts

- Big Iron
  - Cranes
  - Prentice Trucks
  - Forestry Mowers
  - Tree Shear
  - Chippers
  - Grappels
  - Stump Grinders
  - Root Pruners
  - Trenchers
  - Tractors, Trailors

Acme Biomass Reduction

- Process Waste Wood
  - Prunings
  - Whole Trees
  - Landscape Debris
- Facility accepts approximately one quarter million cubic yards of material annually
- Accept a small amount of landscape material and topsoil
- Perform Onsite Processing for Clients

Acme Biomass Reduction

- Big Iron
  - Horizontal Grinders
  - Tub Grinders
  - Whole Tree Chippers
  - Soil Screens
  - Excavators
    - Hoe
    - Shear
  - Loaders
  - Dump Trucks
  - Tractors, Trailors

Acme Biomass Reduction

Acme Biomass Reduction

Acme Biomass Reduction

- Produce
  - Aged Hardwood Mulch
  - Compost
  - Soil Blends
  - Approximately 150,000 cubic yards finished product annually

pogo organics

Beneficial MicroOrganisms

The Biological Approach to Plant & Land Stewardship

- Compost Tea
- Aerated Compost Tea Brewers
- EcoSystem!

17328 Georgia Avenue
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(240) 286-7624
kev@pogoorganics.com

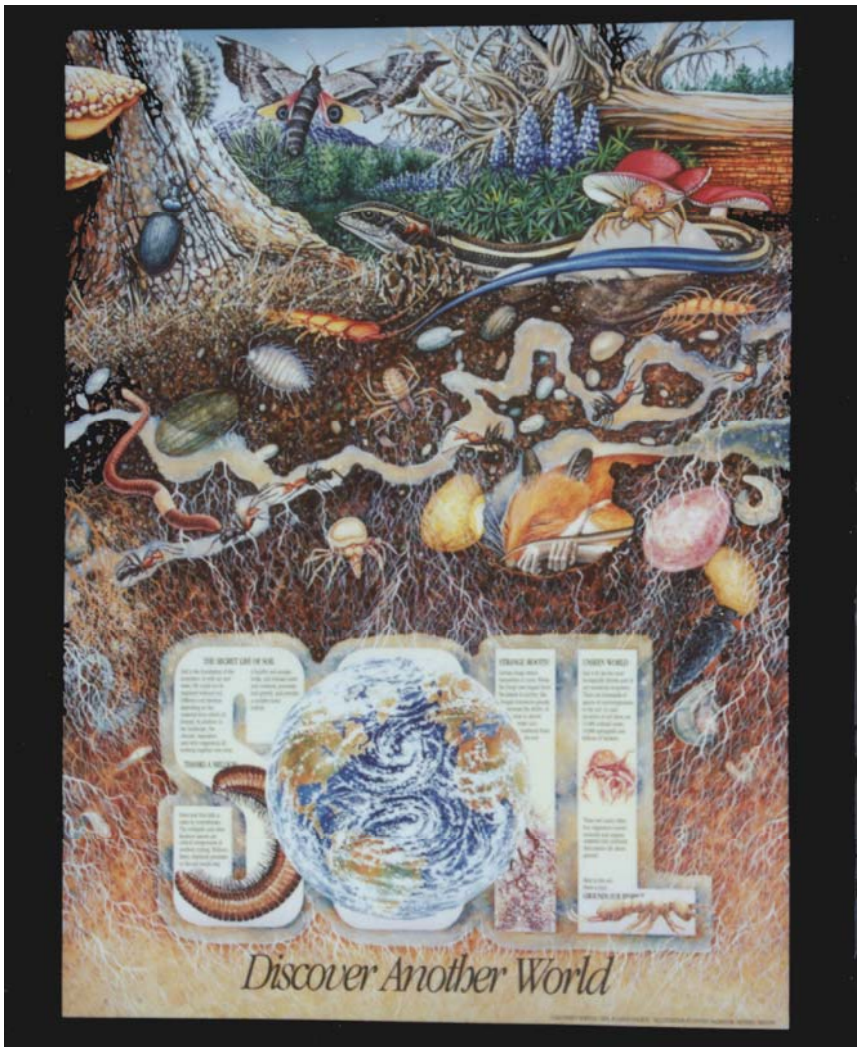
Grow Biologically

A Safe, Natural and Effective Approach to Sustainable Soil Fertility Management

Economically Develop, Support and Maintain Beautiful, Healthy, Durable Landscapes

Introduce **Multitudes** of **Diverse Microorganisms** who form **Mutually Beneficial Relationships** with **Desired Plant Species** and Together Perform the Functions of a **Healthy Soil Food Web!**

Concept:
The Soil Food Web



Dynamic Interactions of Beneficial Microorganisms, Plants and the Environment

Soil

Soil Texture

Soil Chemistry

Soil Biology

Roots

Foliage

Environment

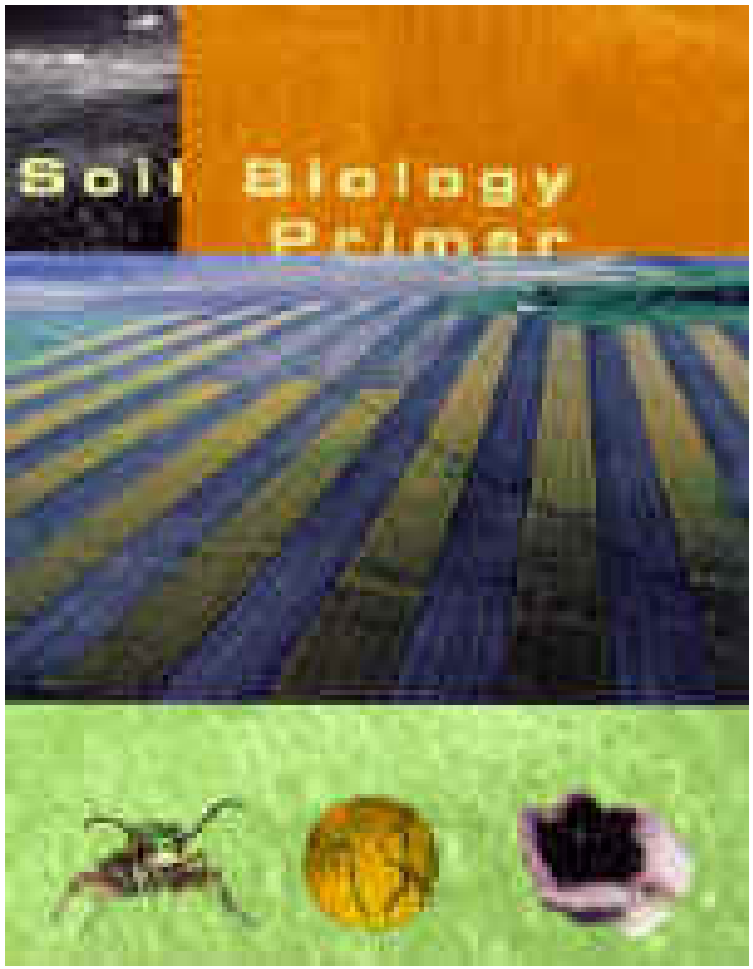
To grow healthy, productive plants, you need soil, roots and foliage with the right balance of organisms.

Plants depend on beneficial soil organisms to:

- **protect them from predators and pathogens**
- **help them obtain nutrients from the soil**
- **break down toxic compounds that could inhibit growth**
- **build good soil structure so water and air can reach the roots in the right proportions**

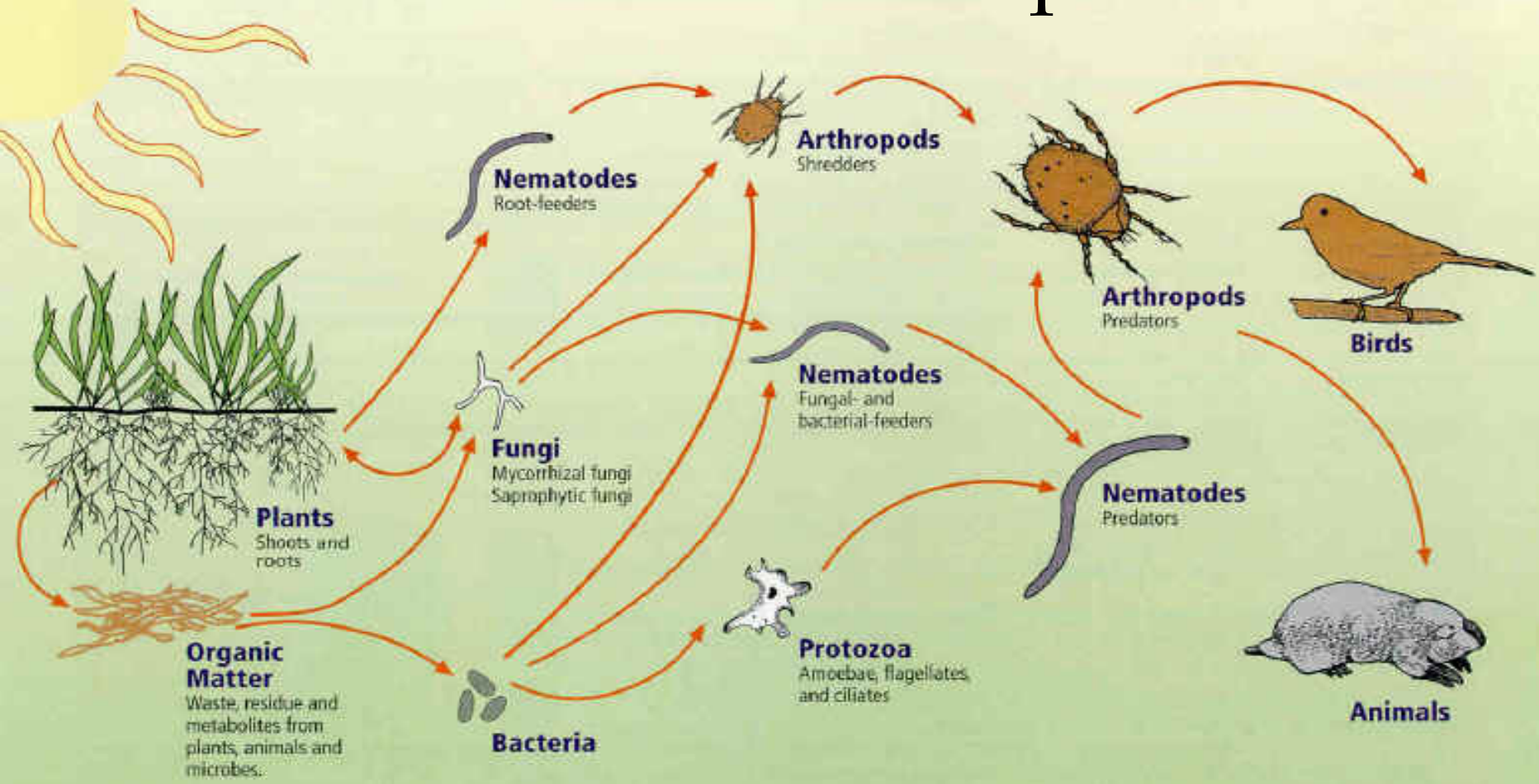
Managing the soil, root and foliar organism environment is a standard and powerful landscape tool.

NRCS Soil Biology Primer



http://soils.usda.gov/sqi/concepts/soil_biology/index.html

The Soil Food Web: Trophic Levels



First trophic level:
Photosynthesizers

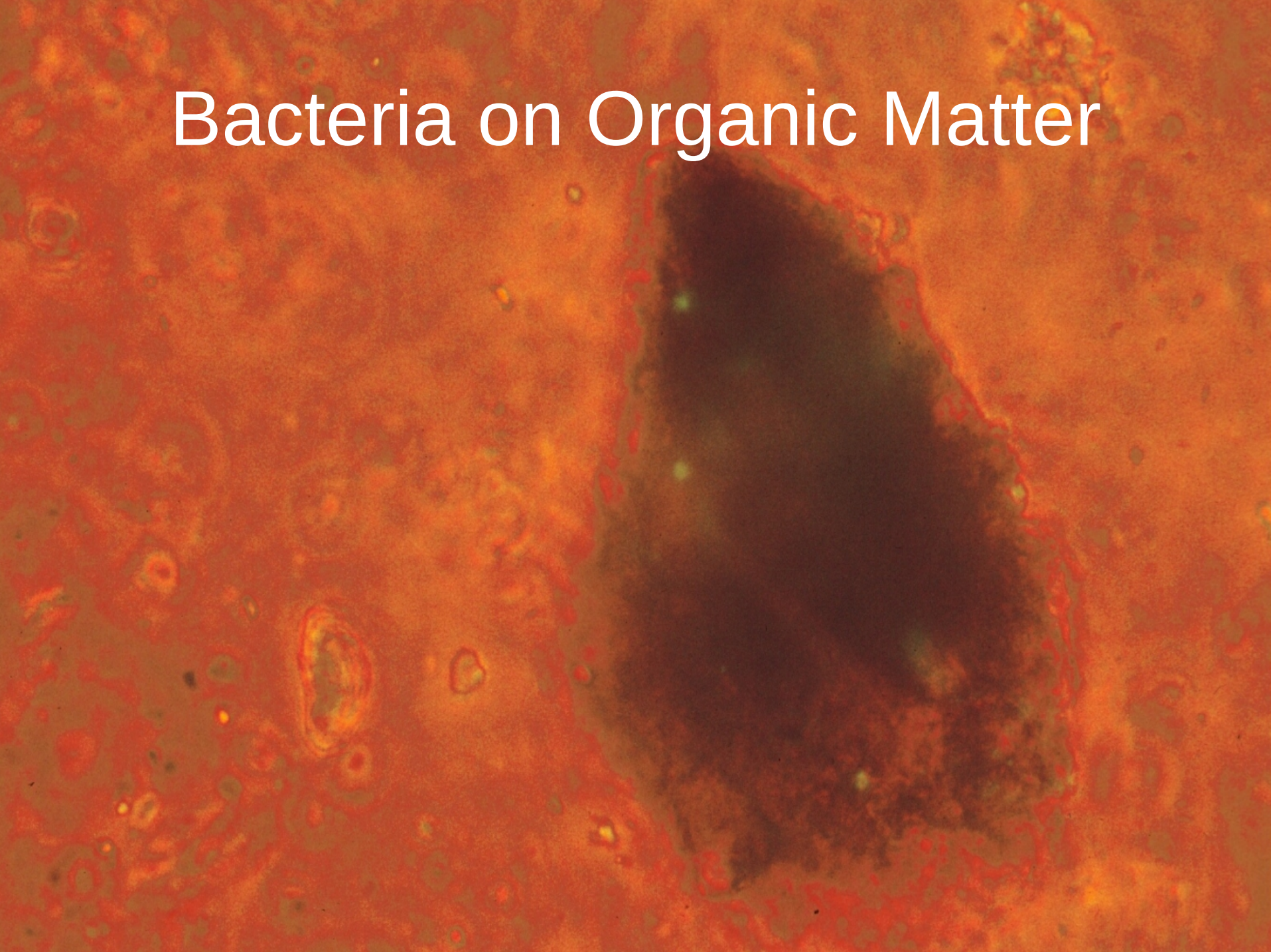
Second trophic level:
Decomposers
Mutualists
Pathogens, parasites
Root-feeders

Third trophic level:
Shredders
Predators
Grazers

Fourth trophic level:
Higher level predators

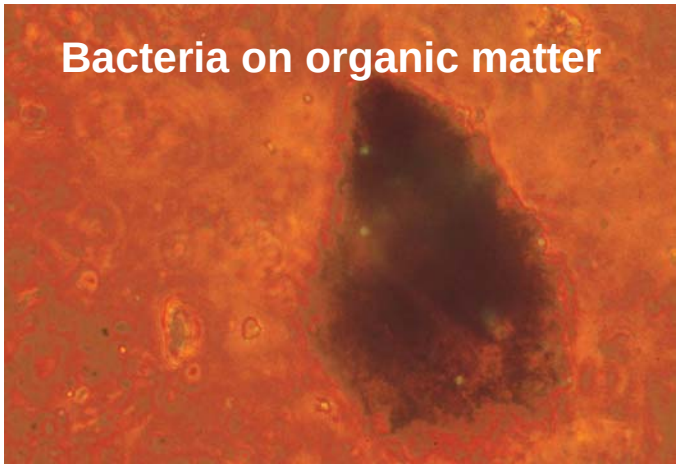
Fifth and higher trophic levels:
Higher level predators

Bacteria on Organic Matter



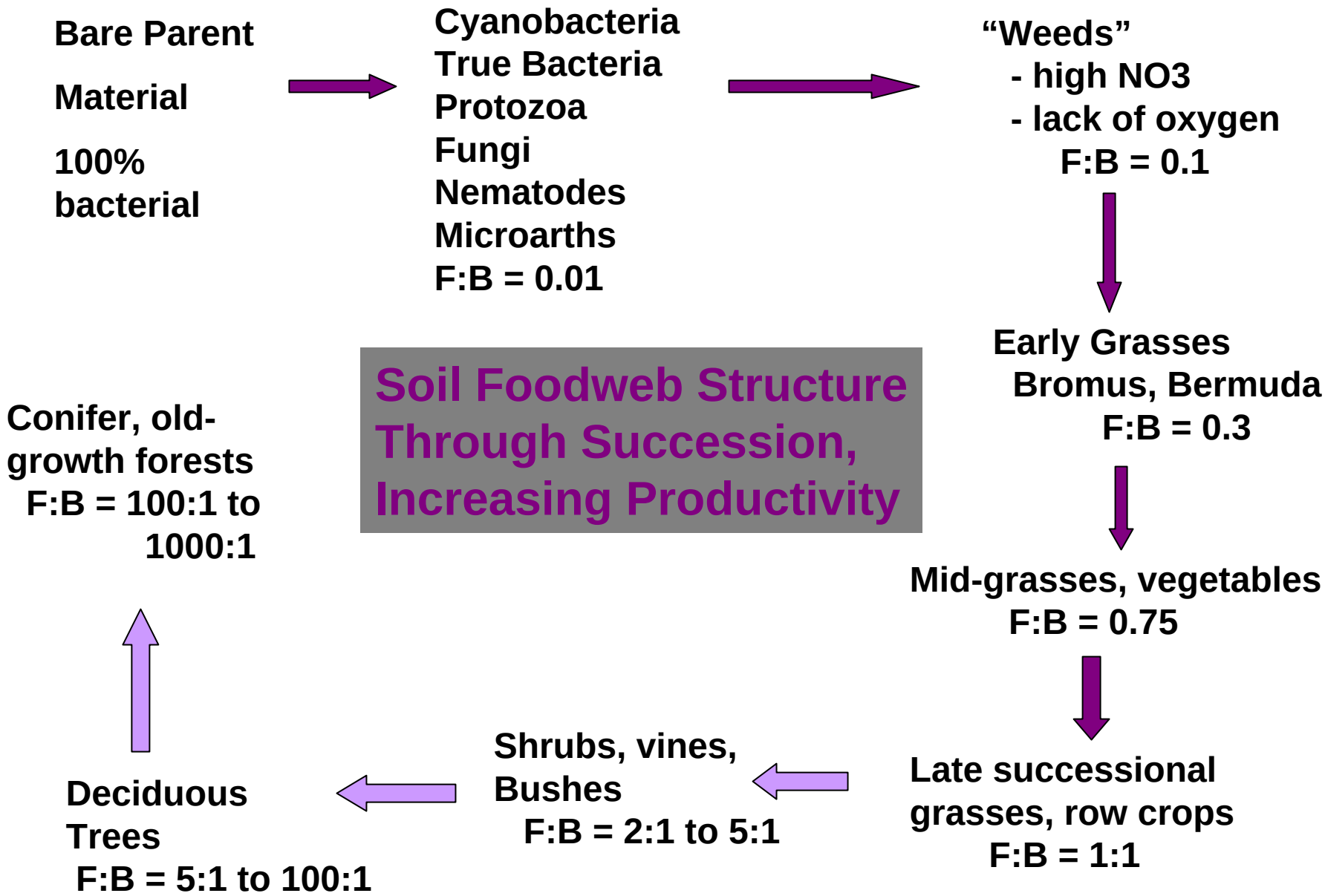

pogo’s fungal wood piles

Bacteria & Fungi

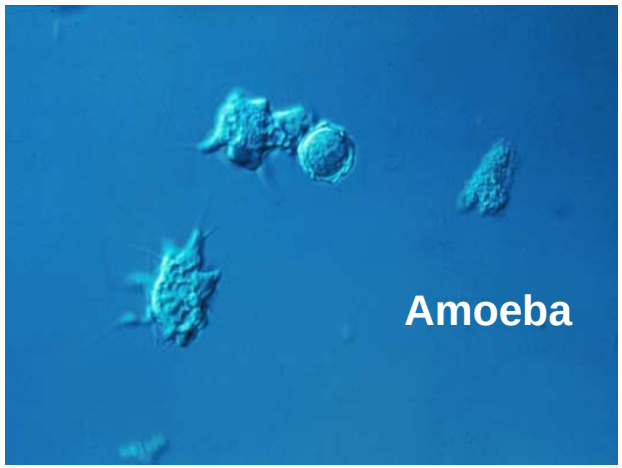


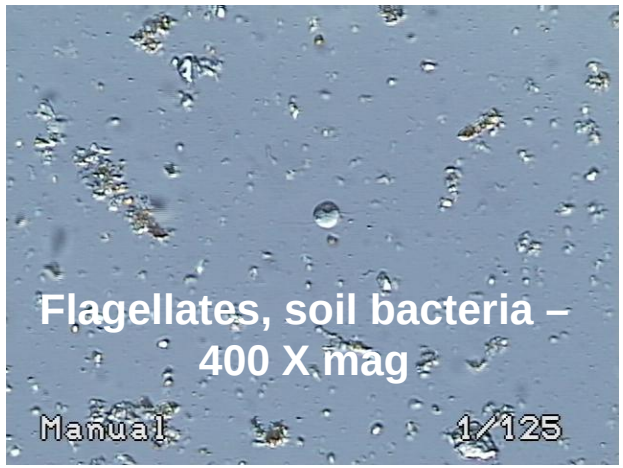
- 80% of compost is living microorganisms
- This organic matter is both food and habitat for bacteria & fungi
- Soil colloids are held together by glues produced by bacteria, making soil micro aggregates which are held together by fungal hyphae, making macro aggregates

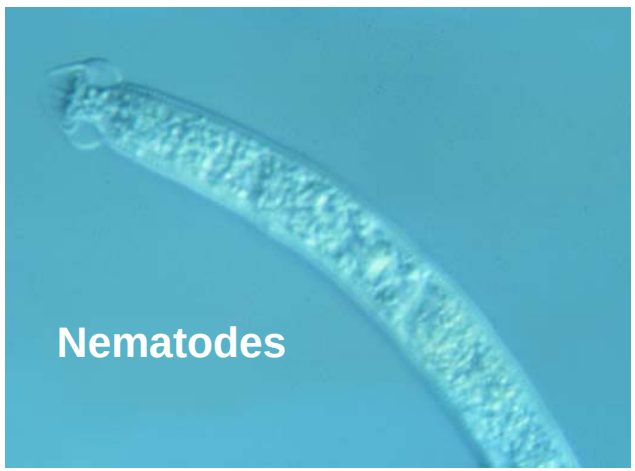
What does your plant need?



Protozoa & Nematodes



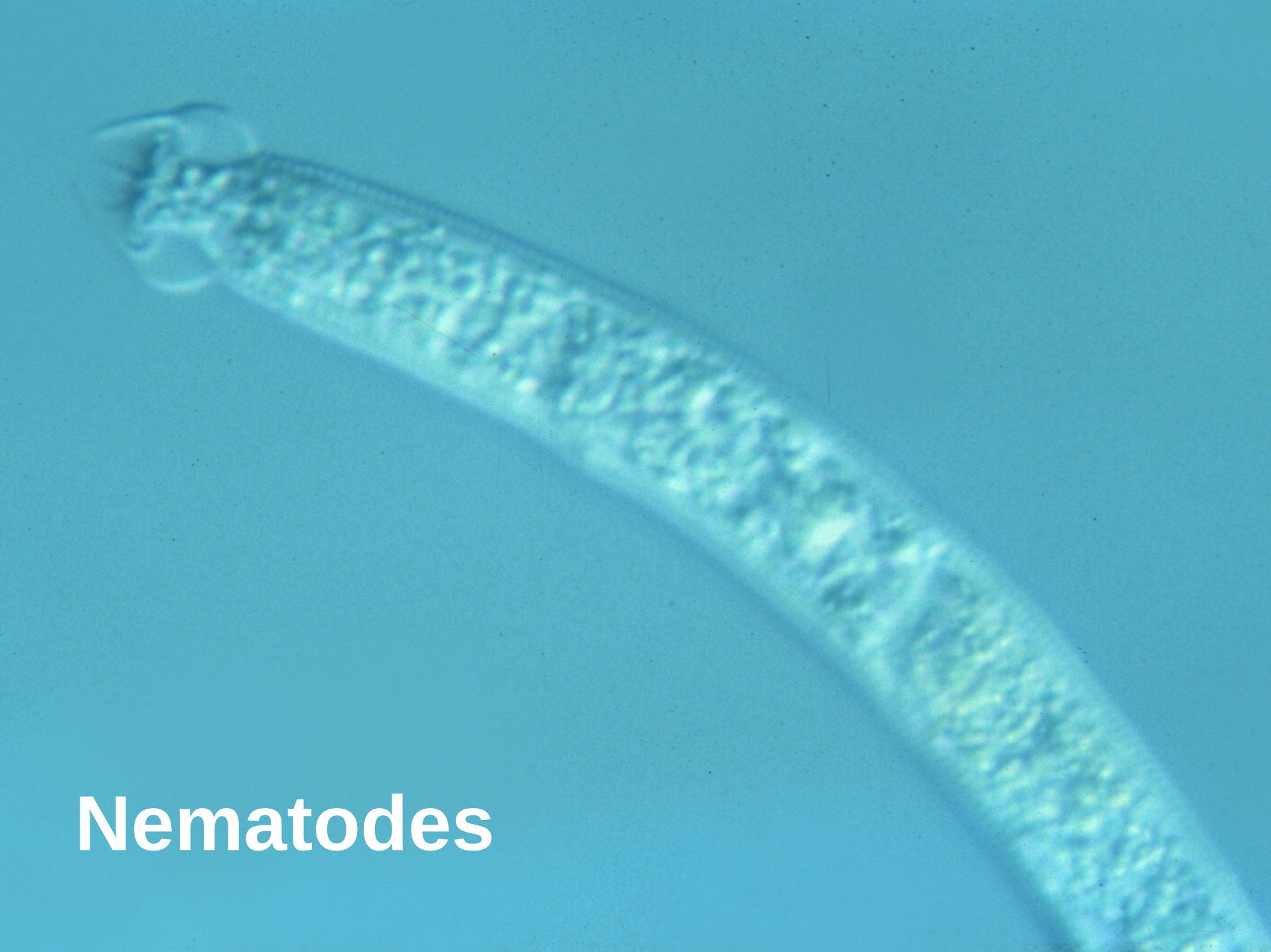





Amoeba


Flagellates, soil bacteria – 400 X mag
Manual
1/125

Ciliates – “Soil Salmon”



Nematodes

Typical Numbers of Soil Organisms in Healthy Ecosystems

Per teaspoon of soil (one gram dry)	Prairie Soils	Forest Soils
Bacteria	110 million to 1 billion.	100 million to 1 billion.
Fungi	Tens to hundreds of yards.	Several hundred yards in deciduous forests; 1 to 40 miles in coniferous forests.
Protozoa	Several thousand flagellates and amoebae, 100 to several hundred ciliates.	Several hundred thousand amoebae, fewer flagellates.
Nematodes	Tens to several hundred.	Several hundred bacterial- and fungal feeders. Many predatory nematodes.

Functions of a **Healthy Soil Food Web**

Nutrient Acquisition, Retention & Cycling
Provide Required Elements in Necessary Molecular Forms
Increase Germination, Biomass and Productivity

Predator & Pathogen Suppression
Competition for Space and Resources
Superior Resilience to Infection

Enhanced Soil Structure Development
Create Soil Aggregates and Porosity
Relieve Compaction, Improve Aeration and Increase Rooting Depth
Build Water Holding Capacity

Toxins Decomposition & BioRemediation
Capability to Reduce Contaminants
Clean Air, Water & Soil

Carbon : Nitrogen Ratio

Bacteria = 5 : 1

Fungi = 10 : 1

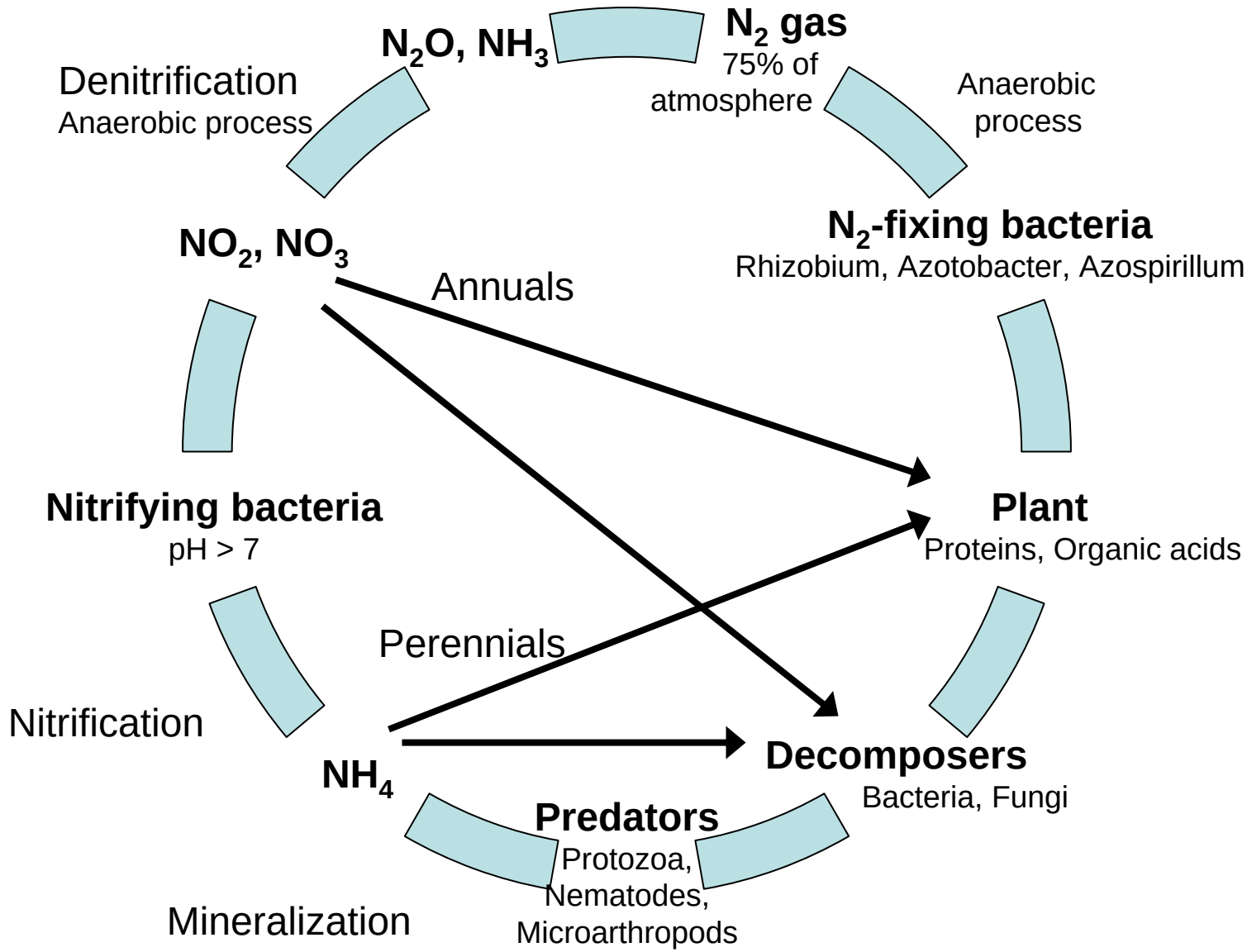
Protozoa = 30 : 1

P eats 6 B satisfying 30C requirement,

Yet, only needs 1N for every 30C.

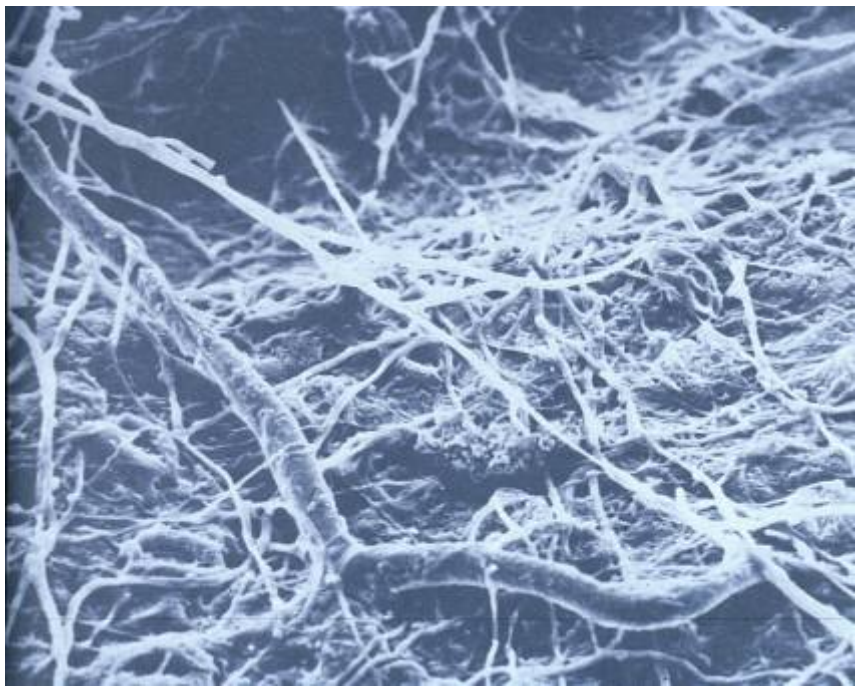
P excretes 5N into plant root zone.

N cycle

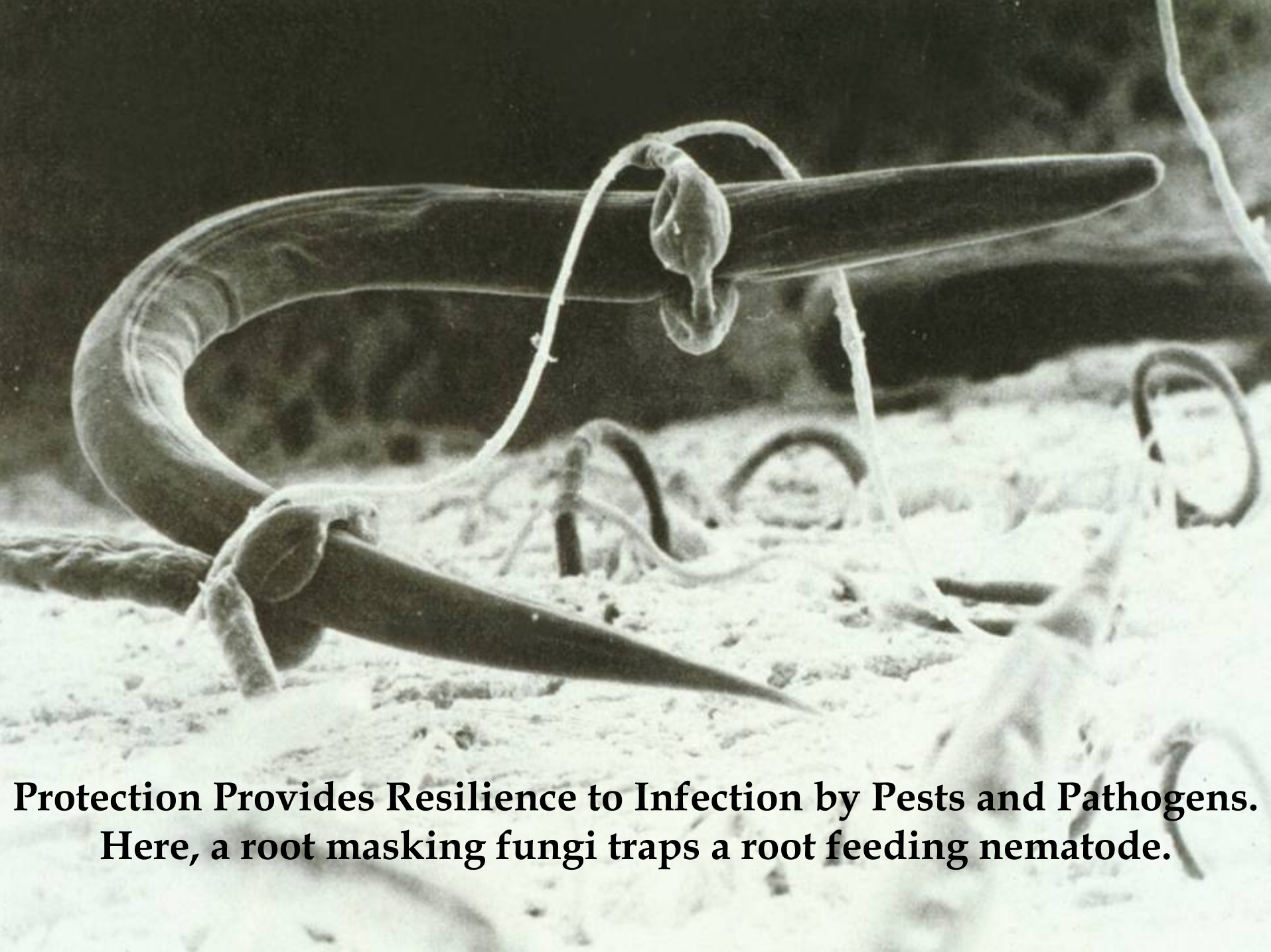

N_2O, NH_3
N_2 gas
75% of atmosphere
Denitrification
Anaerobic process
Anaerobic process
N_2-fixing bacteria
Rhizobium, Azotobacter, Azospirillum
NO_2, NO_3
Annuals
Nitrifying bacteria
pH > 7
Plant
Proteins, Organic acids
Perennials
Nitrification
NH_4
Decomposers
Bacteria, Fungi
Predators
Protozoa, Nematodes, Microarthropods
Mineralization

Beneficial Soil, Root & Leaf Microorganisms

Occupy Space & Consume Resources

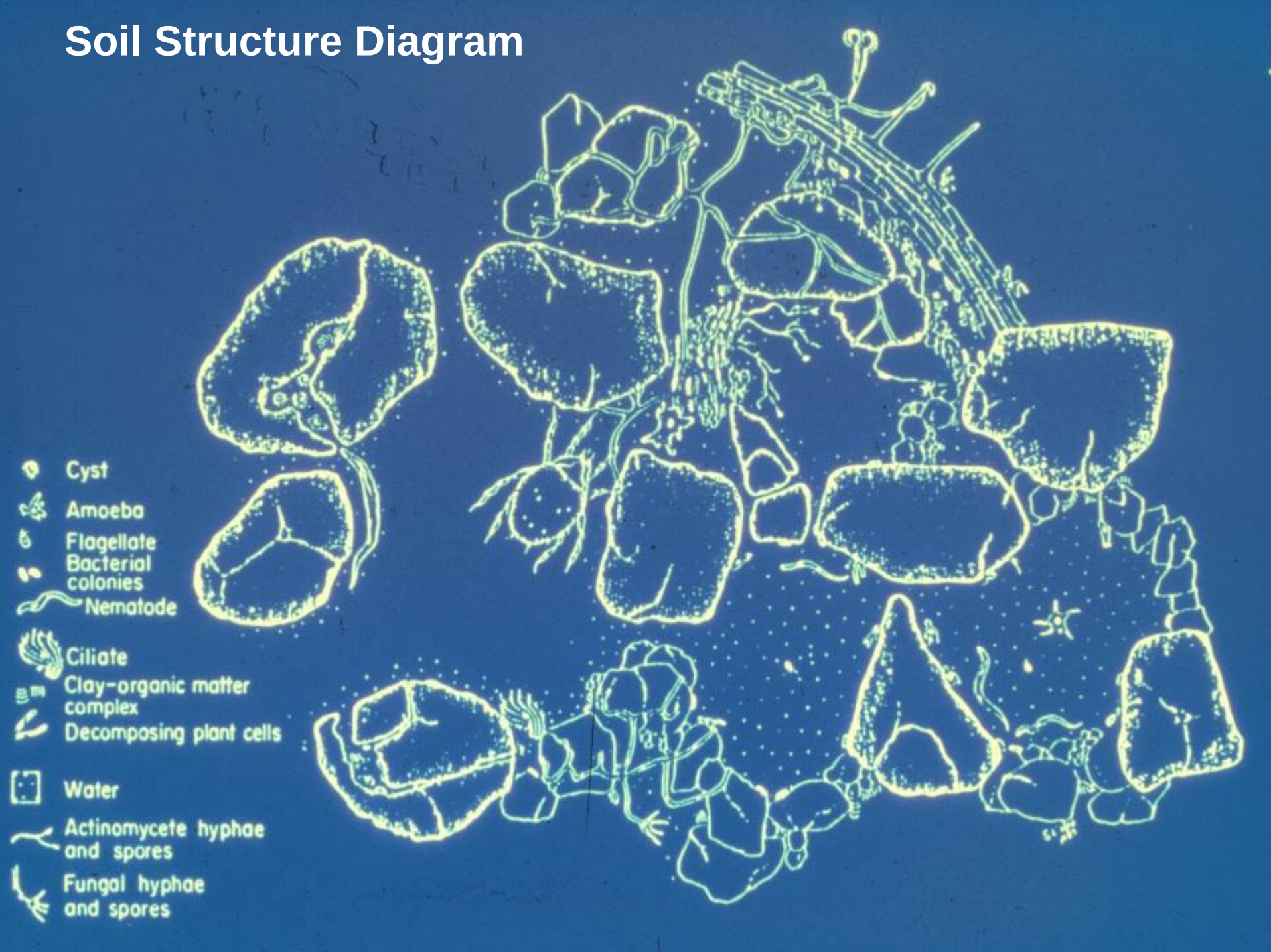


Left: Corn leaf Above: Compost



Protection Provides Resilience to Infection by Pests and Pathogens. Here, a root masking fungi traps a root feeding nematode.

Soil Structure Diagram



SOIL FOODWEB NEW YORK, INC.
555-7 HALLOCK AVENUE
PORT JEFFERSON STATION, NY 11776
(631) 474-8848
info@soilfoodwebnewyork.com

SFNY Compost Foodweb Analysis

Soil Foodweb, Inc.
555-7 Hallock Ave,
Port Jefferson Station, NY 11776 USA
Phone: (631) 474-8848
Fax: (631) 474-8847
e-mail: soilfoodwebny@aol.com

Compost Foodweb Analysis
Pogo
Pogo Sherwood
17328 Georgia Ave
Olney, MD 20832
Fax: (301) 774-3691

Plants: Not Indicated
Sample Received: 11/5/2004
Report Sent: 11/18/04

Organism Biomass Data

Sample #	Unique ID	Dry Weigh of 1 gram Fresh Material	Active Bacterial Biomass (µg/g)	Total Bacterial Biomass (µg/g)	Active Fungal Biomass (µg/g)	Total Fungal Biomass (µg/g)	Hyphal Diameter (µm)	Protozoa Numbers/g Flagellates	Amoebae	Ciliates	Total Nematode Numbers #/g
3906	a Compo	0.582	61.023	1,107.090	103.790	415.690	2.500	73,290	**294**	791	**8.503**
3907	Leaf	0.501	153.388	1,239.214	102.679	908.440	2.750	**8,516**	27,688	919	**4.287**
3908	loupe Co	0.642	74.400	1,479.580	45.261	635.215	2.500	**7,171**	**2,374**	1,295	**6.274**
Bold Means Low		Good moisture content in all 3.	Excellent bacterial activity in all 3.	In good range.	Fungal activity is very high in all 3.	Excellent total fungal biomass.	Good fungal community.	Excellent flagellates in the tea compost; excellent amoebae i the leaf compost. The ciliates are high in all 3, which indicates the presence of fair amounts of anaerobic bacteria.			Low number but fair diversity.
	Desired Range	0.45 - 0.85	15 - 25	100 - 3000	15 - 25	100 - 300	(A)	10000 +	10000 +	50 - 100	20 - 30

Compost Tea
Biological Inoculum
Tool for Shifting Biological Levels

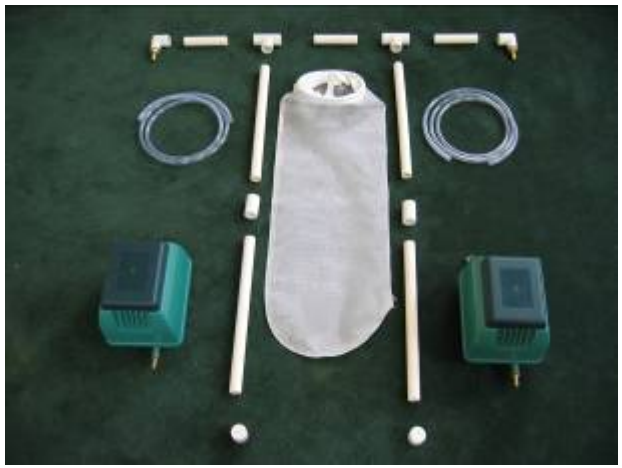
- Compost
- Leaf Compost
- Aged Fungal Hardwood Chips
- Worm Castings

= Compost Tea Compost Blend
(Beneficial MicroOrganisms)

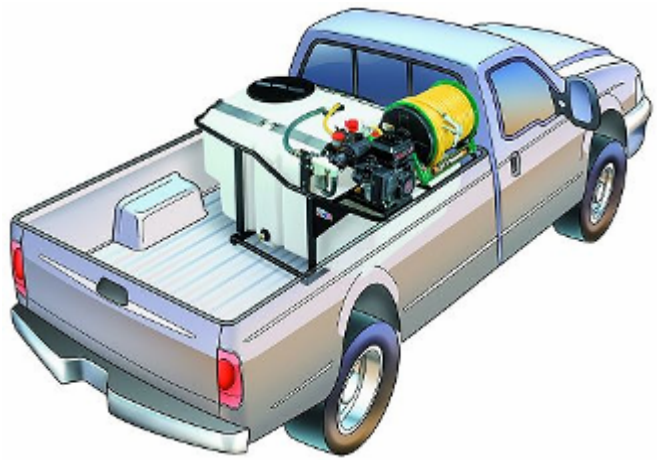
- Humic Acids
- Kelp
- Protein Meal

= Food Blend
(Microbial Foods)

Aerated Compost Tea Brewers



Aerated Compost Tea Brewers



Aerated Compost Tea Brewers

EcoSystem

REJUVENATE!
Pelletized Compost

BENEFIT!
Beneficial MicroOrganisms

ACTIVATE!
Microbial Foods

PROTECT!
EcoSystem Immune Enhancement

Compost Tea Application

Develop & Maintain
Beautiful, Healthy, Durable Plants

<u>Maximize Plant Health & Beauty</u>

- **Amplify Plant Vigor, Color & Density**
- **Increase Annual & Perennial Flowering & Fruit**
- **Improve Turf Germination & Green Up**
- **Superior Foliage with Resilience to Pests & Disease**

Experience lush, robust plants with vitality

<u>Certified Organic</u>

- **Non Toxic & Chemical Free**
- **Child and Pet Safe**
- **Environmentally Sound**

Helps the Chesapeake Bay and its Tributaries

Develop & Maintain
Beautiful, Healthy, Durable Plants

Achieve Soil Structure & Fertility

- Relieve Soil Compaction
- Improve Soil Aeration
- Build Water Holding Capacity
- Supply Necessary Nutrients in Required Forms
- Extend Rooting Depth & Development
- Enhance Capacity for Drought & Stress Tolerance
- Conserve Water
- Reduce Irrigation
- Solve Erosion & Poor Drainage Issues

Reduce Weeds

- Out-compete undesirable plant species

Toxins Decomposition & BioRemediation

- Reduce Contaminants
- Clean Water & Air

Biological Soil Fertility Management Program Development

Initial Meeting with Client

- Discuss Current Client Program Practices
- Discuss Current Client Program Issues
- Introduction to the Soil Foodweb™ Approach
- Discuss Benefits of the Biological Program
- Specify Client Goals of the Biological Program
- Walk and Delineate Biological Program Management Areas
  - Map Site
  - Photograph Areas Delineated as Biological Program Areas
  - Sample
    - Sample Soil for Biology and Chemistry Analysis
    - Sample Leaves for Tissue Analysis
  - Record Field Measurements and Observations
- Submit Samples to Soil Foodweb New York

- SFNY Laboratory Analysis of Biology and Chemistry

Biological Soil Fertility Management Program Development

Follow Up Meeting with Client

- Interpretation and Evaluation of SFI Lab Analysis Report
- Submission and Discussion of Written Recommendations to Client
- Design Biological Soil Fertility Management Program
  - Site Considerations
  - Equipment Considerations
  - Material Supply Considerations
    - Compost
    - Premium Quality Seed
    - Soil Biology Inoculums
    - Microbial Foods
    - Soil Mineral Amendments
  - Logistical Considerations of Program Execution
- Outline Program Implementation

Biological Soil Fertility Management Program Implementation

Program Implementation

- Facilitate Equipment and Material Supply Needs of Client
- Staff Training
- Scheduled Program Operations
  - Aeration
  - Compost Applications
  - Premium Quality Seed Applications
  - Soil Biology Inoculums Applications
  - Microbial Food Applications
  - Mineral Amendment Applications
- Soil and Plant Monitoring
  - Measure, Record and Report Data
- Modification of Program as Necessary

How deep is soil?

Hendrikus Schraven holding roots of ryegrass planted July 15, 2002

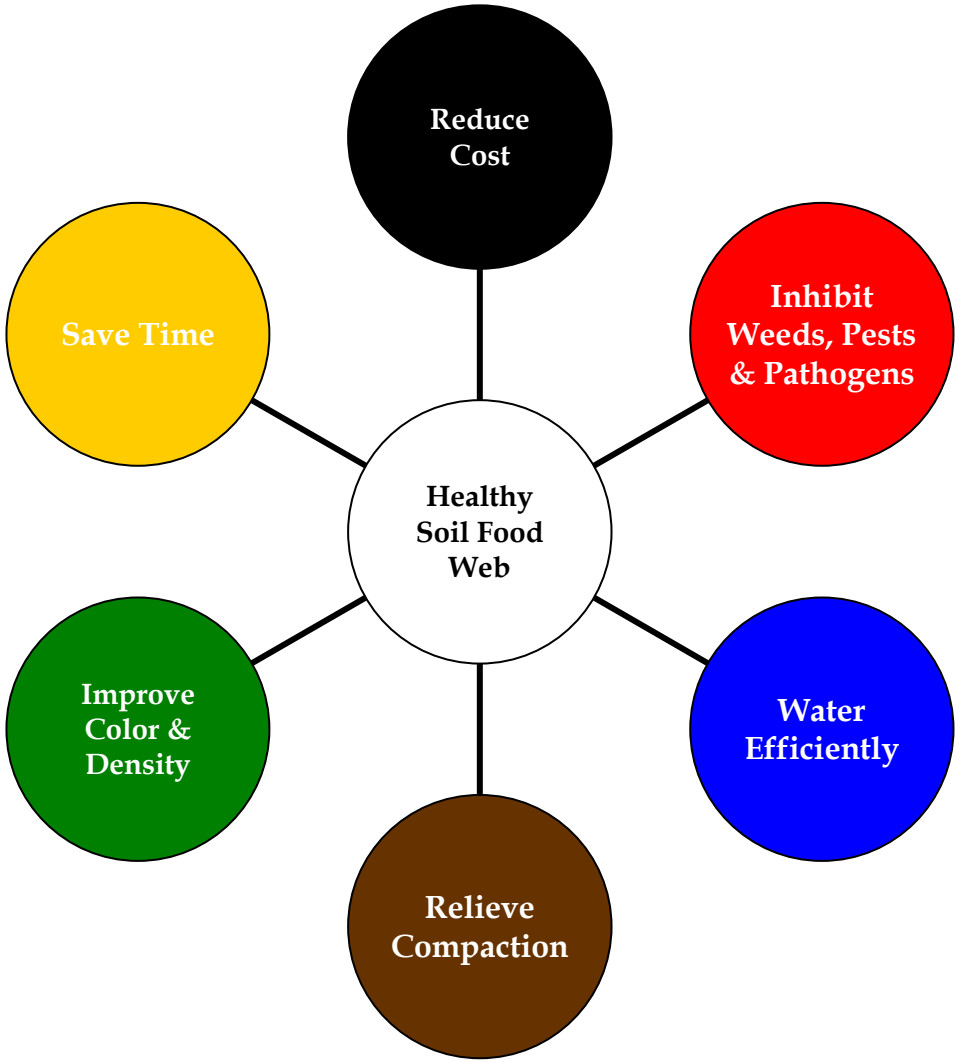
Harvested Nov 6, 2002

Mowed twice to ½ inch

70% **Essential Soil**
30% **Compost with organic fertilizer**
Compost tea once

No weeds, no disease

Biological Soil Fertility Management



pogo organics

Beneficial MicroOrganisms

The Biological Approach to Plant & Land Stewardship

Compost Tea Production | Compost Tea Application Services | Compost Tea Bulk Distribution

- **Balance Soil Biology and Chemistry**
- **Maximize Soil Fertility**
- **Develop a Biological Program with Natural Amendments & Inoculums of Beneficial Microorganisms**

www.pogoorganics.com

pogo organics

Beneficial MicroOrganisms

The Biological Approach to Plant & Land Stewardship

- Education
- Soil Biology & Soil Chemistry
- Sampling, Analysis & Advising
- Biological Plant & Land Management
- Program Development & Implementation
- Erosion Control & Slope Stability
- BioRemediation & Restoration
- Storm Water Management, Water Filtration & Stream Bank Renovation
- Compost & Worm Cast
- Compost Tea
- Soil Blends
- Manufacture
- Sales
- Delivery
- Application
- Equipment & Supply

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pogo organics

Beneficial MicroOrganisms

The Biological Approach to Plant & Land Stewardship

Education & Advising
High Quality Compost & Facilities
Worm Castings, Liquid Worm Castings
Humic Acids, Cold Water Sea Kelp & High Protein Meals

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Aerated Compost Tea Production & Application
ACT Production Equipment
Chesapeake Bay Safe
Effective Nutrient Management
Non Toxic & Chemical Free

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Soil Blends & Installation
Slope Stability, Sediment & Erosion Control
Stream Bank Renovation
BioRemediation & Ecological Restoration
Water Filtration

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Landscape & Arboriculture
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Federal & Municipal Grounds Maintenance
LEEDS Qualification

POGO
Professional Organic Growing Options
Better Greening with Science... Naturally
BENEFIT!

Applied Living Systems

Kevin John Richardson
MycoRestoration

Mobile: (240) 286-7624
Office: (301) 774-2968

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Olney, MD 20832

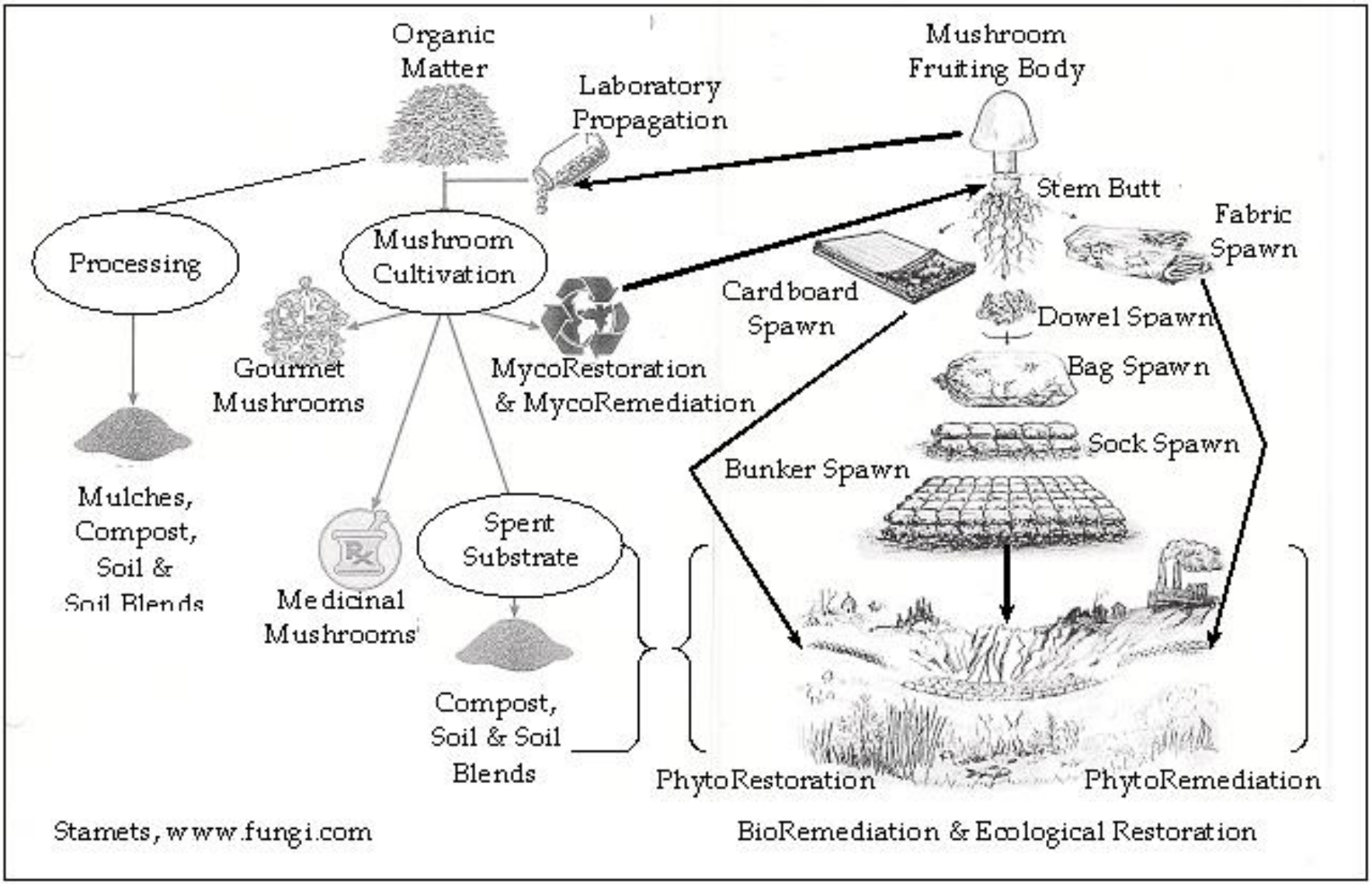
kev@appliedlivingsystems.com
www.appliedlivingsystems.com


Applied Living Systems

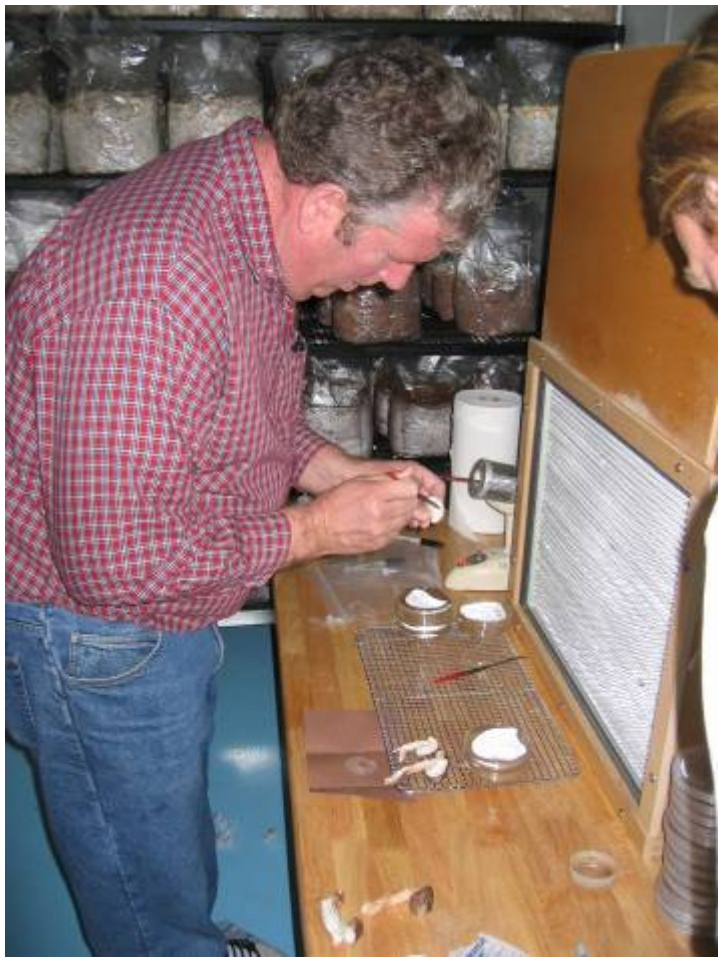
Applied Living Systems

- **Applied Living Systems (ALS) develop and implement biological approaches to land and water restoration.**
- **Our comprehensive systems are based on biomimicry; recognition and imitation of relationships occurring in nature assist in our application of living systems to problems created by disturbance and human impacts.**

BioRemediation & Ecological Restoration



BioRemediation & Ecological Restoration

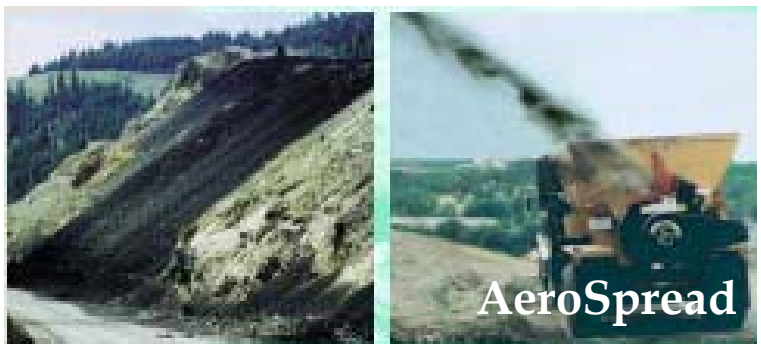


Applied Living Systems

Applied Living Systems

BioRemediation & Ecological Restoration

Substrate Application



BioRemediation & Ecological Restoration

Blower Truck

AeroSpread

Applied Living Systems

- **We assist Land Managers to develop and implement integrated biological systems based approaches to land and water restoration projects:**
- **Storm Water Management**
- **Erosion & Sediment Control**
- **Slope Stabilization**
- **Stream Bank Restoration**
- **Pollution Prevention**
- **Water Filtration**
- **Waste Water Management**
- **Toxins Remediation**
- **Ecological Restoration**

Applied Living Systems

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(240) 286-7624
kev@appliedlivingsystems.com

FUNGI PERFECTI® LLC

YOUR SOURCE FOR THE BEST IN GOURMET AND MEDICINAL MUSHROOMS

MYCOVA℠

Helping the Ecosystem through Mushroom Cultivation
Adapted from the article, "Earth's Natural Internet" by Paul Stamets, published in the Fall 1999 issue of *Whole Earth Magazine*

Oyster mushrooms fruiting on diesel contaminated soil at a test bioremediation site effectively decontaminating the soil. MycorestorationSM is the use of fungi to help repair or restore ecologically harmed habitats.

“A trial project at a vehicle storage center controlled by the Washington State Dept. of Transportation (WSDOT) enlisted the techniques from several, competing bioremediation groups. The soil was blackened with oil and reeked of aromatic hydrocarbons. We inoculated one berm of soil approximately 8 feet x 30 feet x 3 feet high with mushroom spawn while other technicians employed a variety of methods, ranging from bacteria to chemical agents. After 4 weeks, the tarps were pulled back from each test pile. The first piles employing the other techniques were unremarkable. Then the tarp was pulled from our pile, and gasps of astonishment and laughter welled up from the observers. The hydrocarbon-laden pile was bursting with mushrooms! Oyster mushrooms up to 12 inches in diameter had formed across the pile. Analyses showed that more than 95% of many of the PAH (polycyclic aromatic hydrocarbons) were destroyed, reduced to non-toxic components, and the mushrooms were also free of any petroleum products.

“After 8 weeks, the mushrooms had rotted away, and then came another startling revelation. As the mushrooms rotted, flies were attracted. (Sciarid, Phorid and other "fungus gnats" commonly seek out mushrooms, engorged themselves with spores, and spread the spores to other habitats). The flies became a magnet for other insects, which in turn brought in birds. Apparently the birds brought in seeds. Soon ours was an oasis, the only pile teeming with life! We think we have found what is called a "keystone" organism, one that facilitates, cascade of other biological processes that contribute to habitat remediation. Critics, who were in favor of using plants (as in "phytoremediation") and/or bacteria, reluctantly became *de facto* advocates of our process since the mushrooms opened the door for this natural sequencing.

“In this series of experiments, our group made two other significant discoveries. One involved a mushroom from the old growth forest that produced an army of crystalline entities advancing in front of the growing mycelium, disintegrating when they encountered *E. coli*, sending a chemical signal back to the mother mycelium that, in turn, generated what appears to be a customized macro-crystal which attracted the motile bacteria by the thousands, summarily stunning them. The advancing mycelium then consumed the *E. coli*, effectively eliminating them from the environment. The other discovery, which I am not fully privy to, involves the use of one of my strains in the destruction of biological and chemical warfare agents. The research is currently classified by the Defense department as one mushroom species has been found to break down VX, the potent nerve gas agent Saddam Hussein was accused of loading into warheads of missiles during the Gulf War. This discovery is significant, as VX is very difficult to destroy. Our fungus did so in a surprising manner.

“We believe that buffer zones around streams work primarily because of the mycelium resident in the first few inches of soil. Buffers with multi-canopied trees and shrubs combined with grasses, and the debris fall-out they provide, afford a mycologically rich zone, filtering out run-off from adjacent farms, highways and suburban zones. The mycologically rich riparian zones are cooler, attract insects which lay larvae (grub for fish), and then foster bird-life. Once the riparian zones achieve a plateau of complexity, they become self-sustaining. Amazingly, I have not heard of a single researcher ever mention the primary role fungi play in riparian buffers, let alone the purposeful introduction of mycelial colonies to protect watersheds. This method is ingeniously simple in its design and yet seemingly out of grasp of politicians. The prejudice against mushrooms is a form of biological racism—mushrooms are just not taken seriously.

“Mycofiltration is a natural fit to John Todd's "Living Machine®" use of estuary ecosystems to break down toxic wastes. The marriage of upland use of mushroom mycelium with estuary environments could solve—in the short term—some of the greatest challenges threatening our ecosystem, and truly give meaning to the word "sustainability". We are currently moving towards unifying these two friendly technologies in the creation of a new paradigm for the 21st century. However, we need help.”

BioRemediation & Ecological Restoration

Applied Living Systems may employ specific species of fungi, cultivated at our laboratory that have activity against the following toxins:

- Anthracenes
- Benzopyrenes
- Chromated Copper Arsenate
- Chlorine
- Dioxin
- Estrogens
- Persistent Organophosphates (POPs)
- Polycyclic Aromatic Hydrocarbons (PAHs)
- Polychlorinated Biphenyls (PCBs)
- Pentachlorphenols (PENTAs)
- Trinitritoluene (TNT)

June

August

October

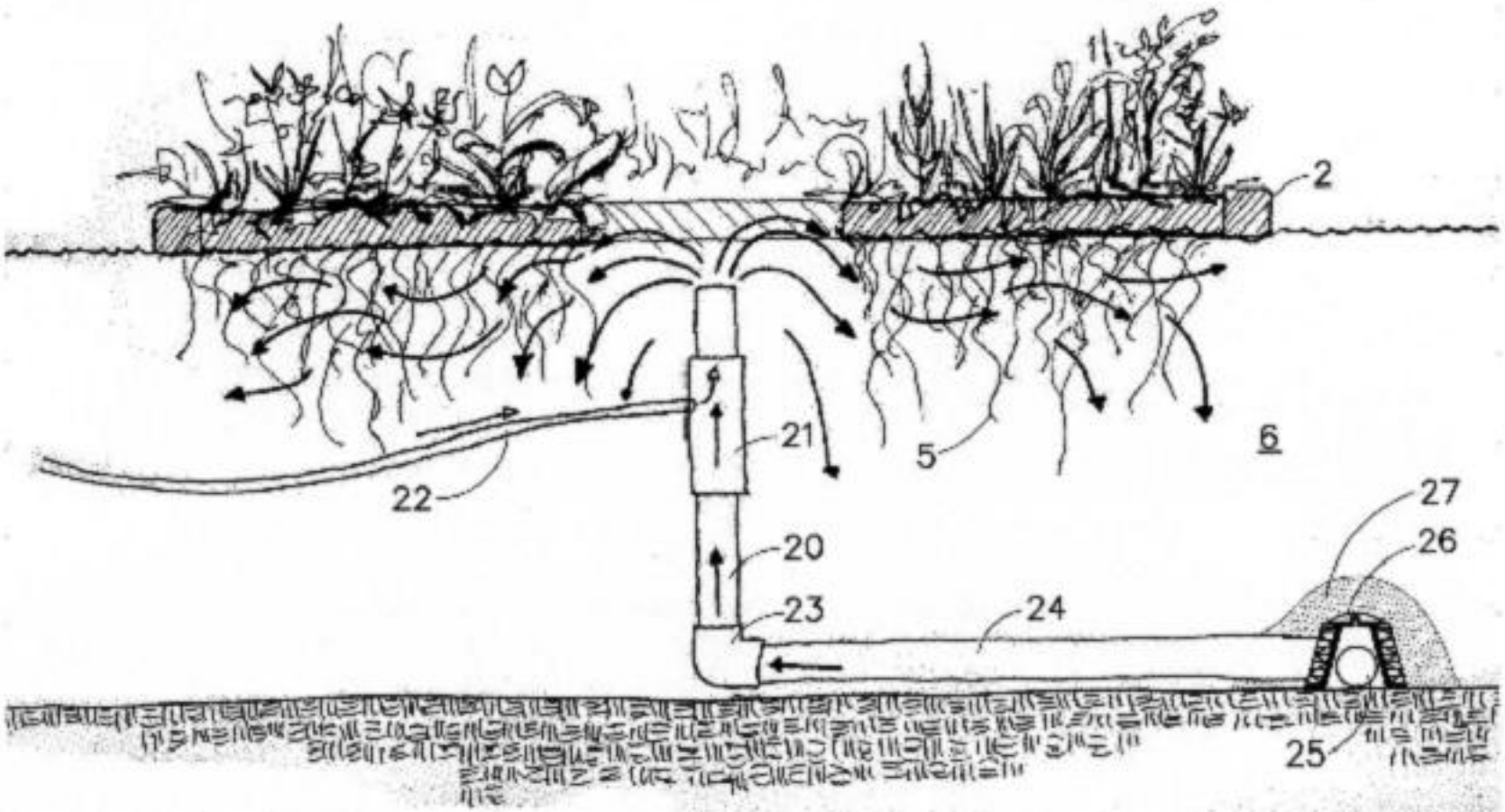
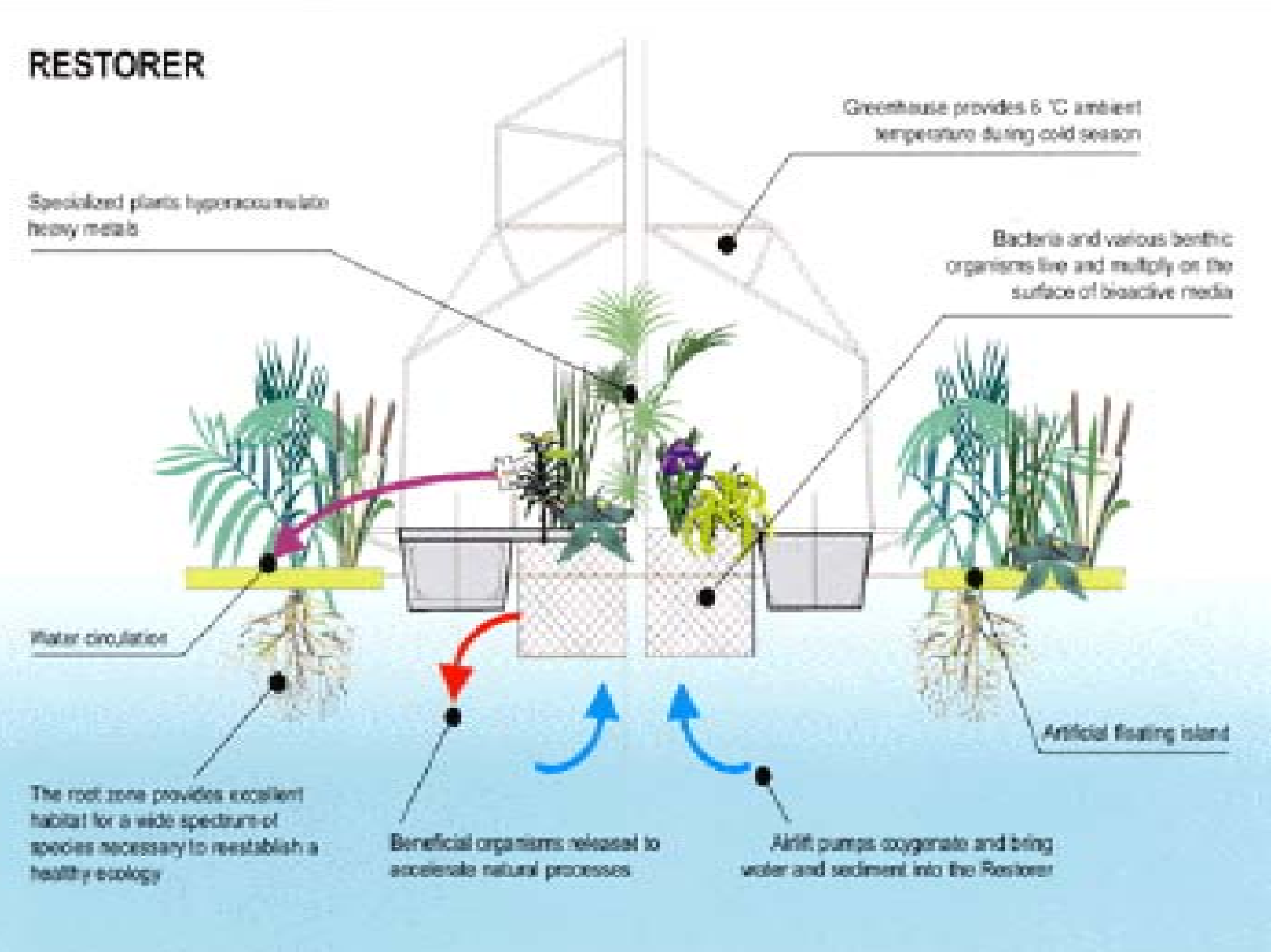


FIG. 6 SECTION

RESTORER


Greenhouse provides 6 °C ambient temperature during cold season
Specialized plants hyperaccumulate heavy metals
Bacteria and various benthic organisms live and multiply on the surface of bioactive media
Water circulation
Artificial floating island
The root zone provides excellent habitat for a wide spectrum of species necessary to reestablish a healthy ecology
Beneficial organisms released to accelerate natural processes
Airlift pumps oxygenate and bring water and sediment into the Restorer

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29 10 03

West Hawaii Today
FRIDAY, APRIL 22, 2005 WESTHAWAIITODAY.COM 50¢

TRAVIS LOOP | WEST HAWAII TODAY

David Chai, director of natural resources at the Four Seasons Resort Hualalai, points to the pond which won an award for its use of phytoremediation.

FOUR SEASONS POND WINS ENVIRONMENTAL PROTECTION AGENCY AWARD

BY TRAVIS LOOP
WEST HAWAII TODAY
tloop@westhawaiitoday.com

When a chef at Four Seasons Resort Hualalai needs fish or shrimp for a dish, a fresh supply is available at the fifth hole of the golf course.

That's where the "living machine" is located.

The 3-million-gallon pond is an example of phytoremediation — the treatment of environmental problems using plants.

Water in the Four Seasons pond is filtered by floating islands of plants with extensive root systems that are colonized by nutrient-consuming bacteria. The water is then clean enough to be stocked with moi, mullet, milkfish and Pacific White Shrimp, which are used in the resort restaurant.

The pond — dubbed a "living machine" for its use of micro-organisms — was recognized by the Environmental Protection Agency at an awards ceremony Thursday in San Francisco. The facility is only one of two recipients from the state.

"The selection for the award was based on the promotion of innovative ideas, addressing of environmental problems over the long term and the ability to be replicated in other places," said Dean Higuchi, EPA press officer in Honolulu.

The pond, called Lake Punawai, was built in 2001 with the requirements of being energy efficient, visually pleasing and able to provide fish for the restaurant, said David Chai, director of natural resources at Four Seasons Resort Hualalai. The resort partnered with Natural Systems Inc. and

► SEE POND PAGE 4A

> **"When the EPA looked at this project, we saw a good example of how a business can interact with the environment and turn it into something positive for both their operations and natural resources."**
>
> DEAN HIGUCHI
> EPA PRESS OFFICER IN HONOLULU

▶ POND: System allows fish, shrimp to be grown, saves money

CONTINUED FROM PAGE 1A

Ocean Arks International to create a phytoremediation system that met the criteria.

Two-and-a-half acres in size and 10 feet in depth, the pond is lined with a foot of gravel and features two floating islands of plants. Chai said bacteria and micro-organisms were introduced to the root systems and gravel bed.

A three-horsepower pump circulates water through the islands, allowing plants and bacteria to remove pollution and excess nutrients, such as phosphorus and nitrogen.

"We have basically built a mini-ecosystem to keep the pond clean and remove waste from the fish," Chai said.

About 80,000 shrimp and thousands of fish live in the pond and can be harvested for the resort restaurant. Oysters are also found in the waters, although their role is in filtration, not food.

The pond saves energy costs for the Four Seasons as well, Chai said.

"If we set up another area as a fish pond without this system, it would cost close to $10,000 a month in power — this one runs about $400," Chai said.

TRAVIS LOOP | WEST HAWAII TODAY

On the fifth hole at the Four Seasons Resort Hualalai's golf course, a pond was built four years ago that filters water through plants, allowing fish and shrimp to be grown in the pond and used at the resort's restaurant.

The dual benefits for the environment and Four Seasons also contributed to the selection for an EPA award.

"When the EPA looked at this project, we saw a good example of how a business can interact with the environment and turn it into something positive for both their operations and natural resources," Higuchi said.

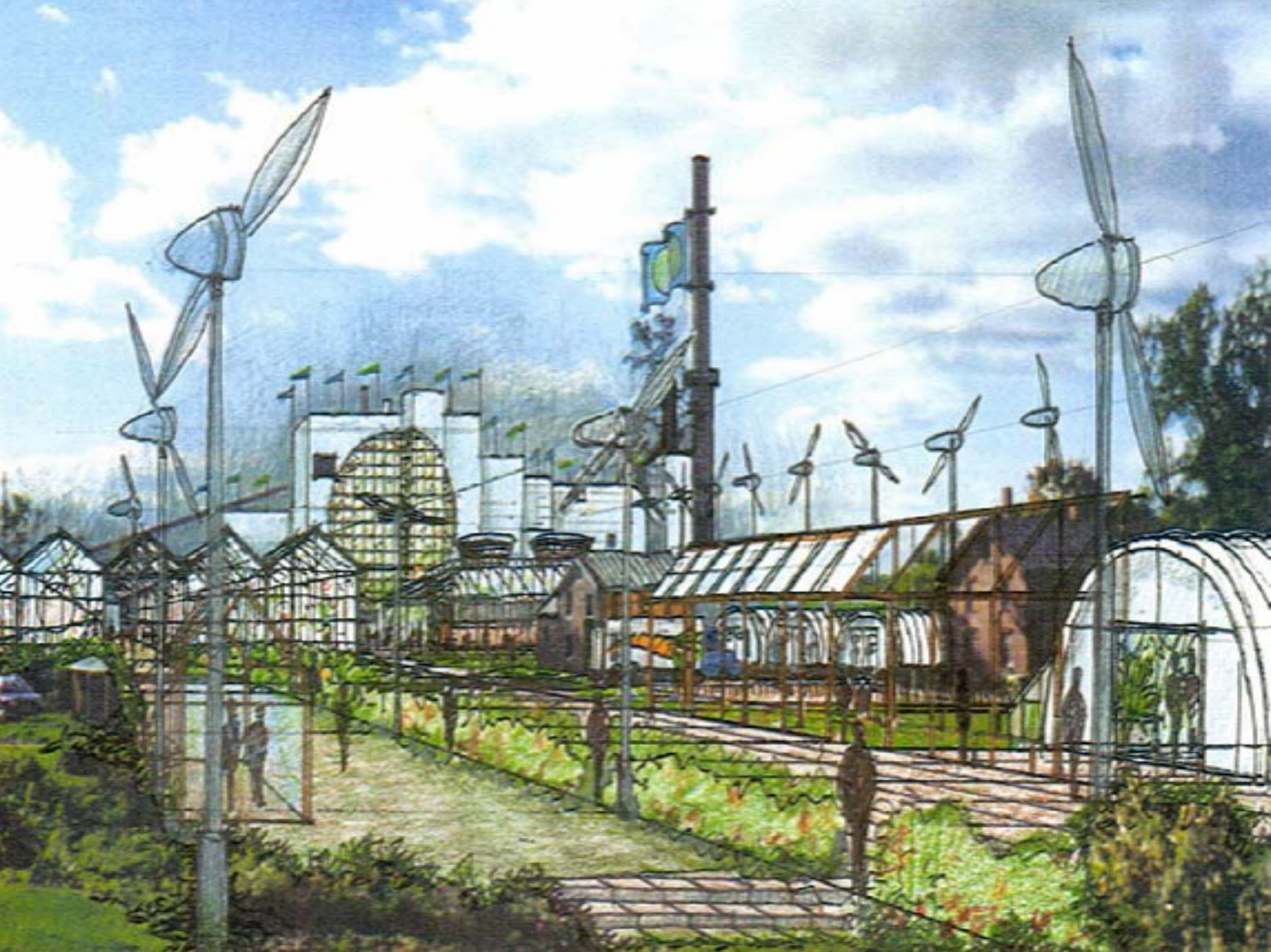
Honolulu officials hope to replicate the pond's success in the heavily polluted Ala Wai Canal, which borders Waikiki. Pending approval by the state Board of Land and Natural Resources, a 3,396-foot-long, 30-inch-wide floating platform of plants would be placed in the canal to clean up the urban waterway, according to an Oahu newspaper.

Letter from the Four Seasons

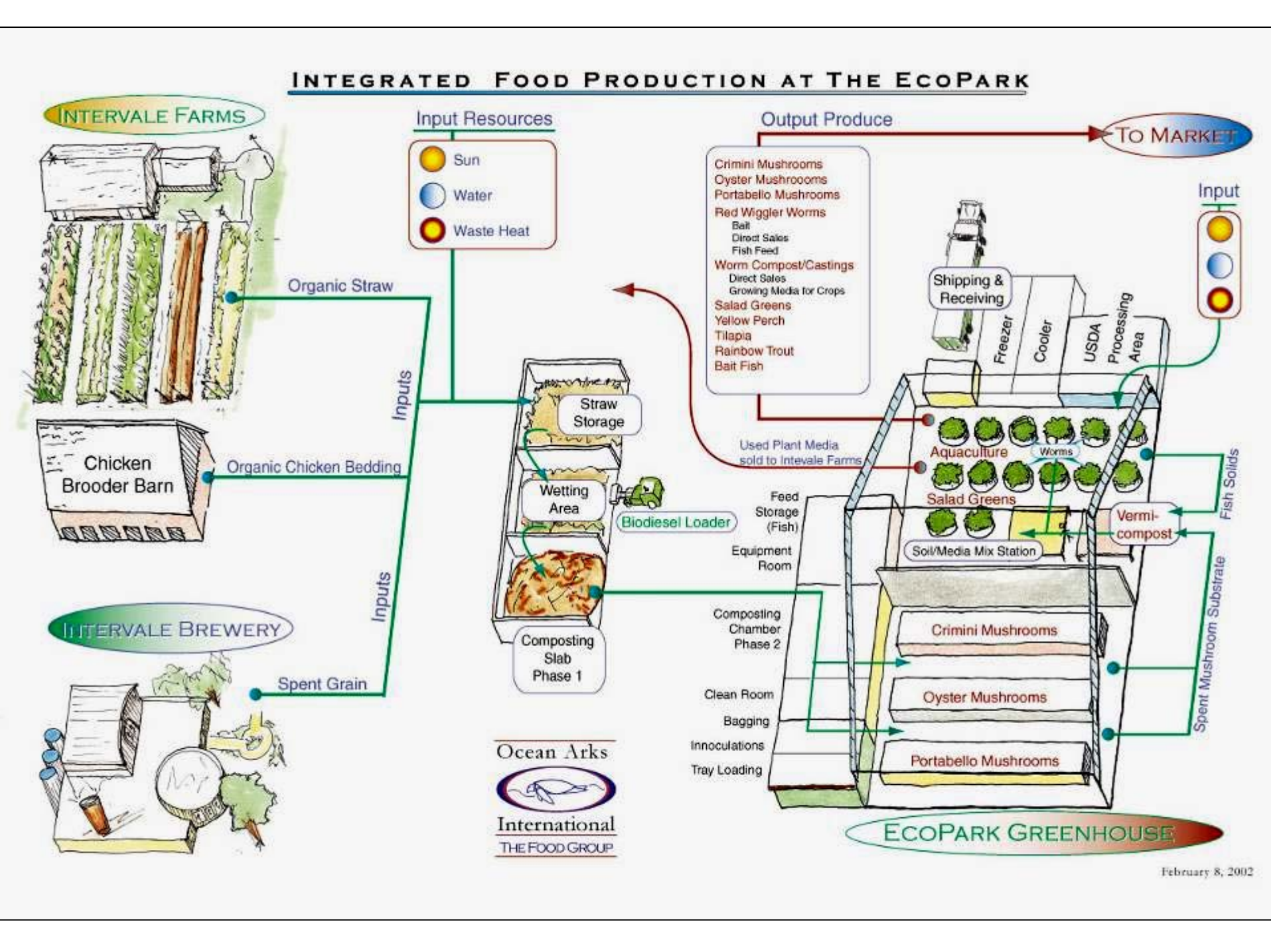
- Morris,

  The filtration system installed by Ocean Arks Int. using 2 restorers for our 3 million gallon golf course water feature has worked amazingly well. In addition to having an aesthetic water feature, we stocked our brackish-water lake with 80,000 Pacific White shrimp 300,000 oysters, and nearly 6,000 fish in an attempt at aquaculture to supply our Resort restaurants. After 2 years of operation our aquaculture venture is still going strong and the lake looks beautiful. Operating costs are minimal compared to other lakes of similar size, and we attribute this to an efficient natural filtration method. Low nutrient levels are consistently maintained, and the lake bottom has absolutely no accumulation of silt or debris.

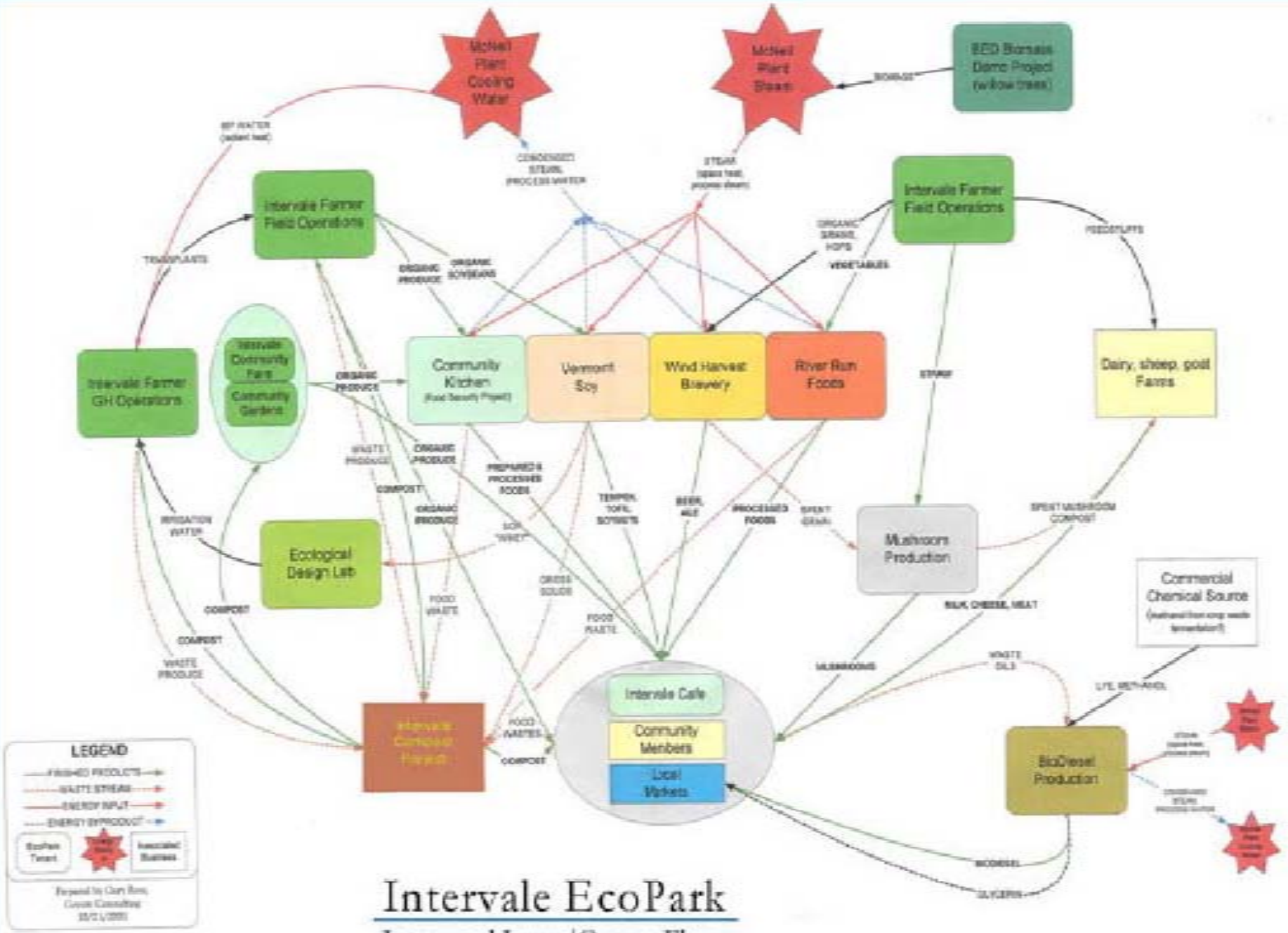
  David Chai
  Hualalai Resort
  Natural Resources Manager



Integrated Food Production at The EcoPark



February 8, 2002



Intervale EcoPark

Integrated Input/Output Flows

MARKETS

MAGIC HAT

BIOSOLIDS

MUSHROOMS

MUSHROOM PRODUCTION

SOLIDS

SOLIDS SEPARATION

LIQUID

TRICKLING FILTER

SOLIDS

WORMS

VERMICULTURE

FIXED FILM BIOSOLIDS

SOLIDS

MAGIC HAT BREWERY WASTE WATER TREATMENT PROCESS FLOW SCHEMATIC

ALGAL TURF SCRUBBER

LIQUID

BARTLETT BAY WWTP

BAGGED SOIL AMMENDMENT

WORM CASTINGS

ALGAE AS FEED

LIQUID

SOLIDS

AQUACULTURE AND AQUAPONICS AT SOUTH BURLINGTON LIVING MACHINE

FERTILIZER

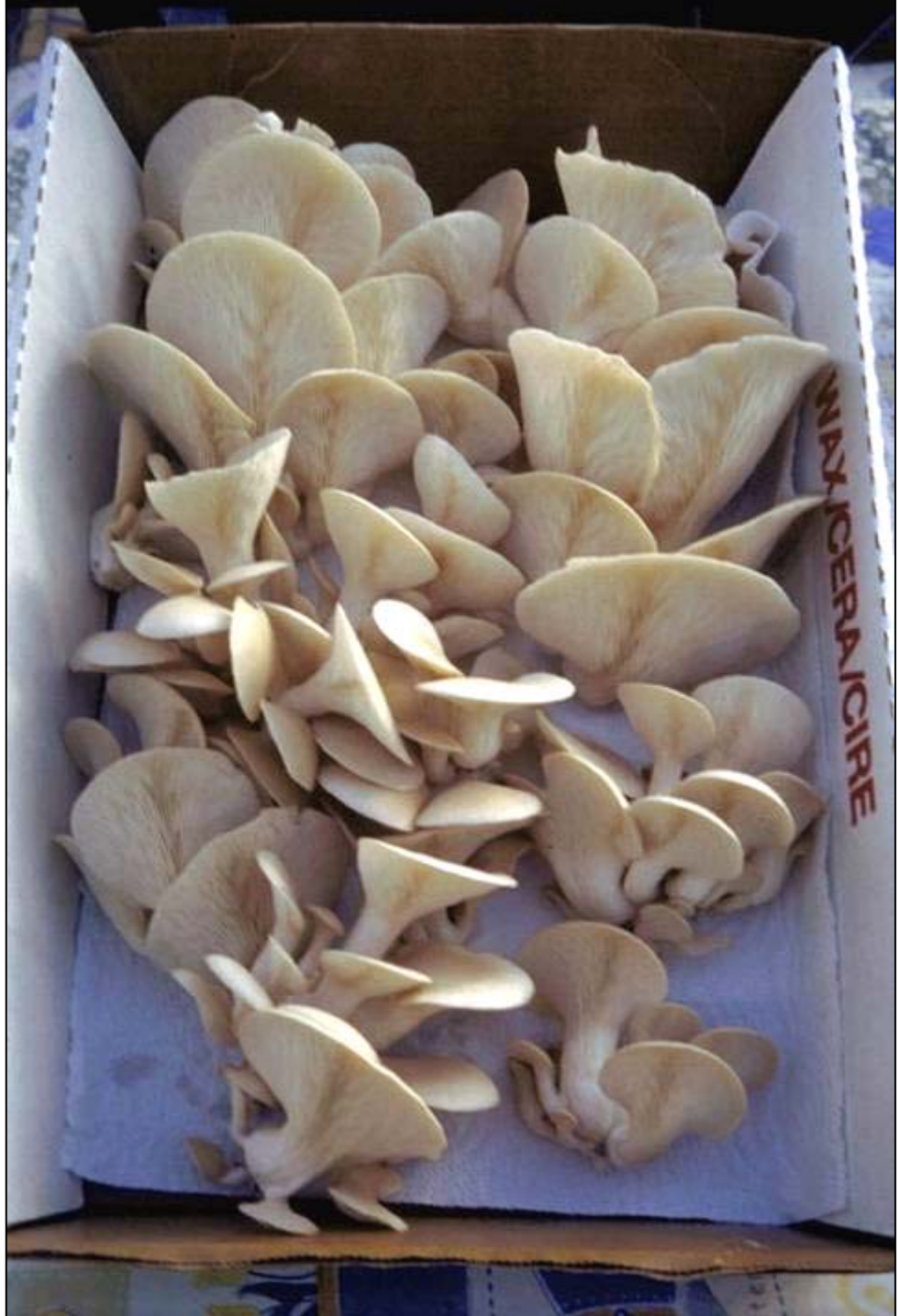
VERMICOMPOST TEA

EDUCATIONAL PROGRAMS

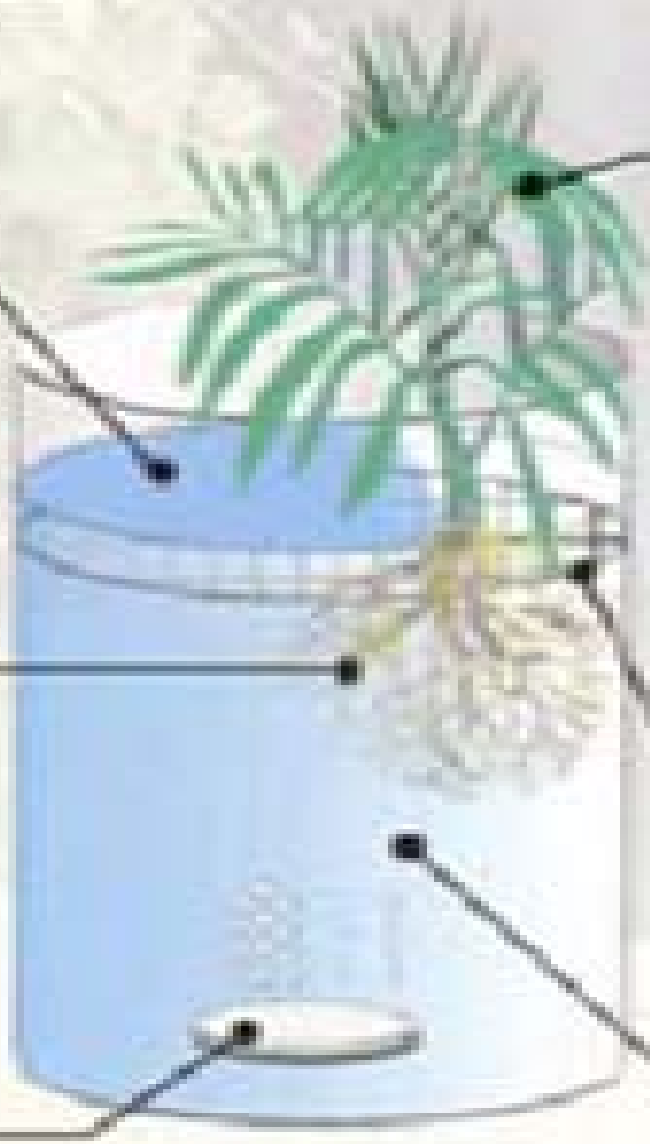
FISH, FLOWERS, & VEGETABLES

OCEAN ARKS INTERNATIONAL

COMMUNITY OUTREACH


WAX/CERA/CIRE

THE OPEN AEROBIC REACTOR



water surface

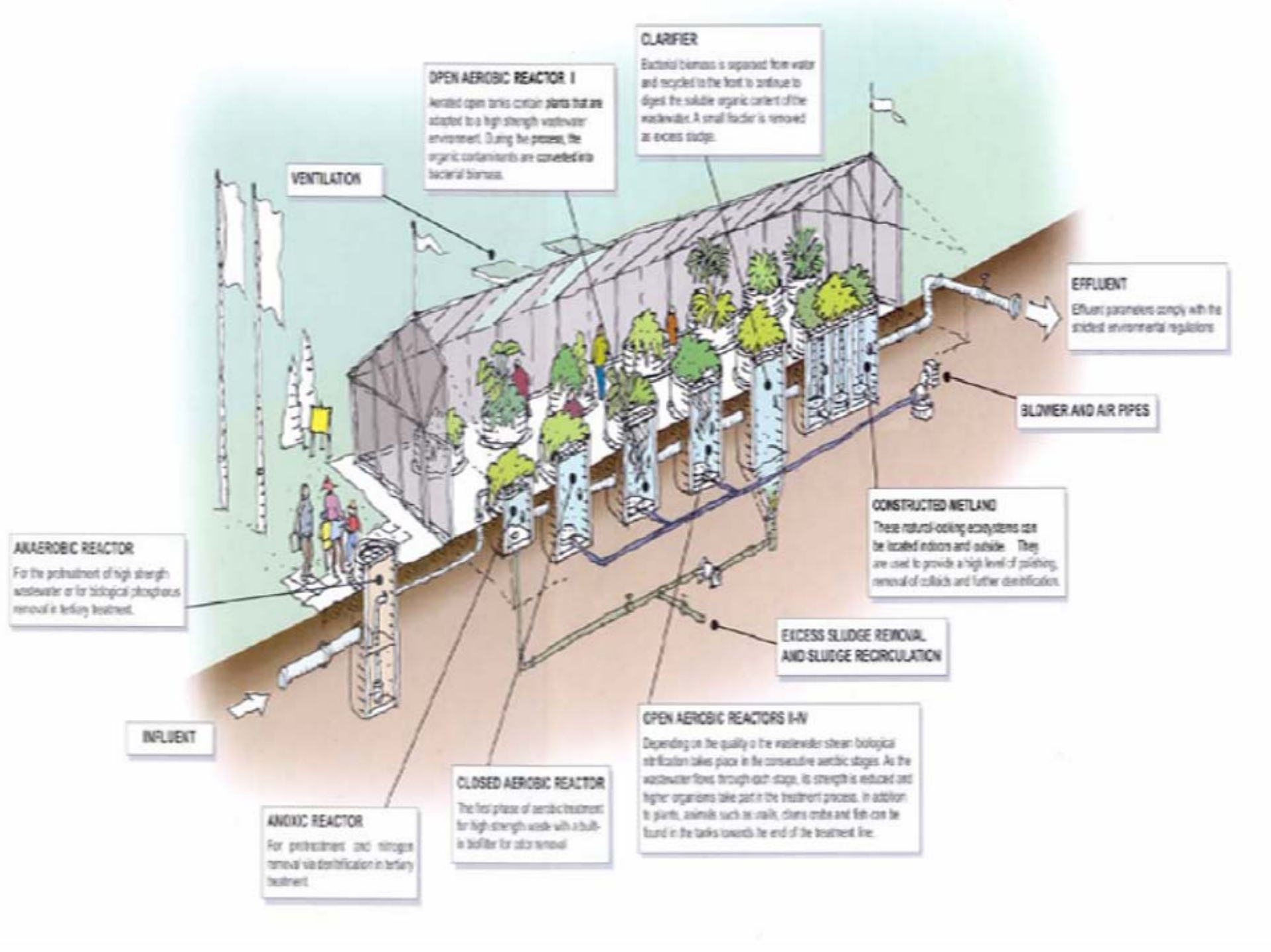
the root system with its large surface area serves as an excellent natural attached growth media

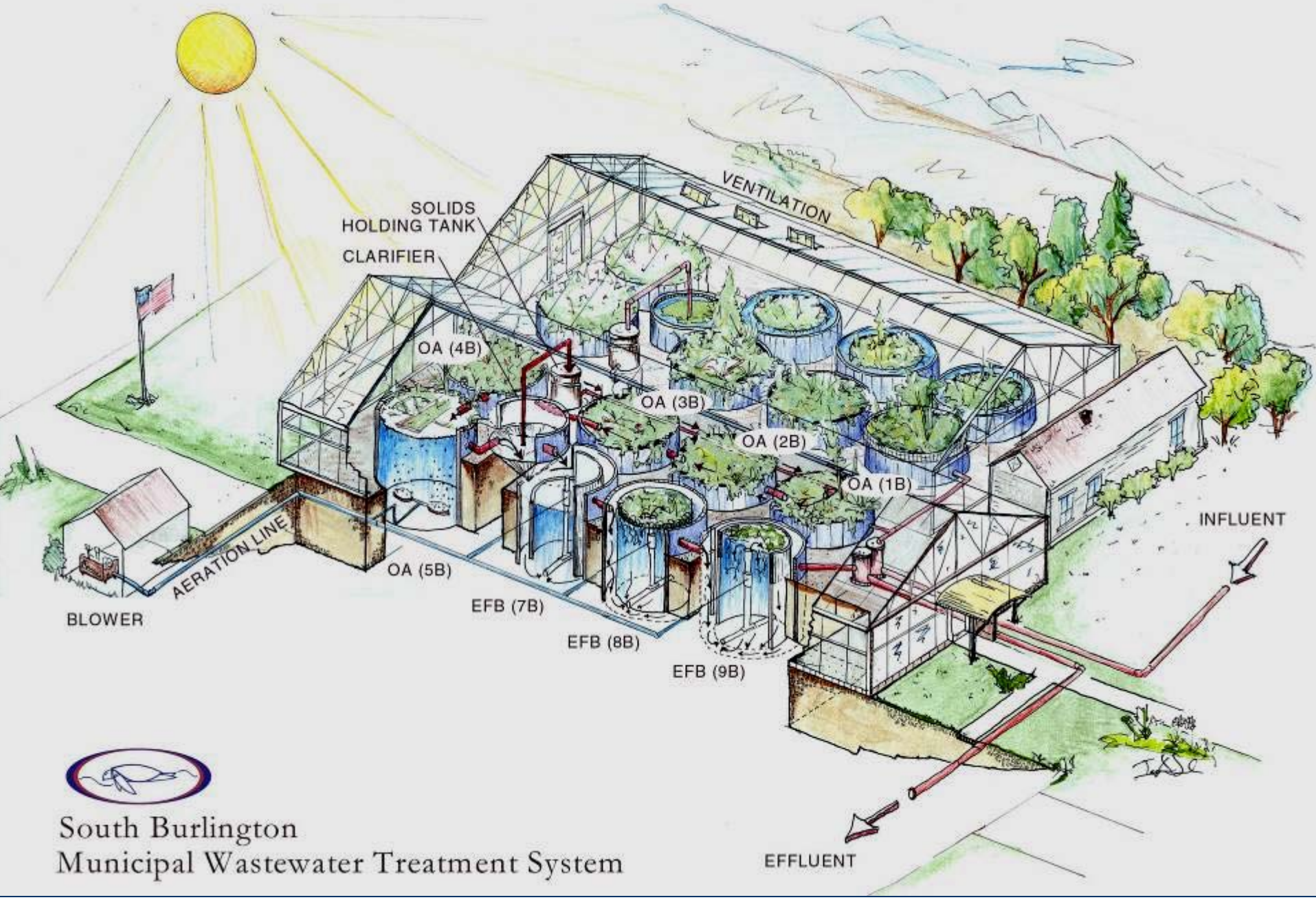
fine bubble aerator

plants provide habitat for various species, pump oxygen into the water and uptake nitrogen and phosphorus compounds

plant supporting mesh

bacterial mass in suspension

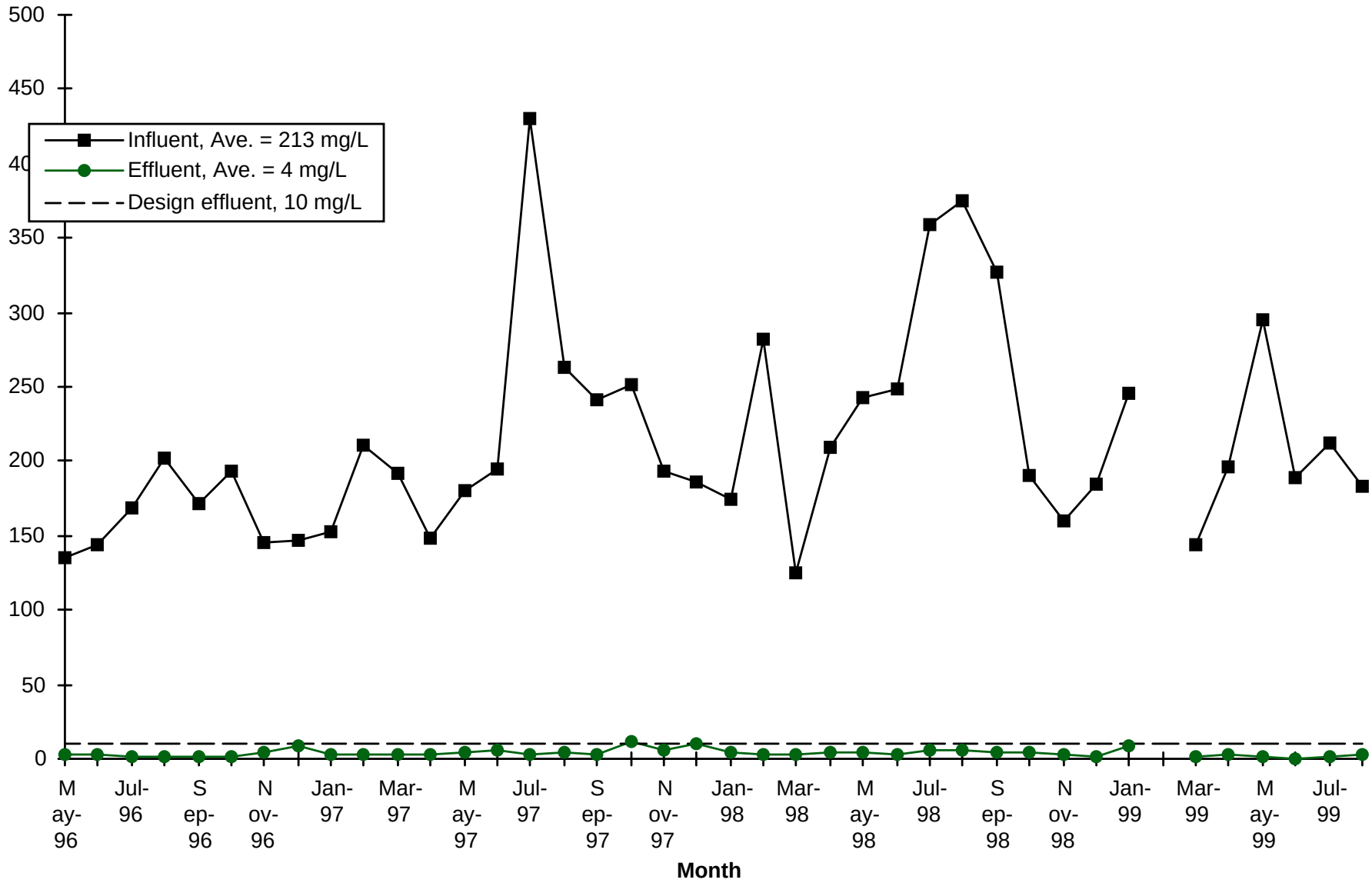

CLARIFIER
Bacterial biomass is separated from water and recycled to the front to continue to digest the soluble organic content of the wastewater. A small fraction is removed as excess sludge.
OPEN AEROBIC REACTOR I
Aerated open tanks contain plants that are adapted to a high strength wastewater environment. During the process, the organic contaminants are converted into bacterial biomass.
VENTILATION
EFFLUENT
Effluent parameters comply with the strictest environmental regulations
BLOWER AND AIR PIPES
CONSTRUCTED WETLAND
These natural-looking ecosystems can be located indoors and outside. They are used to provide a high level of polishing, removal of colliods and further disinfection.
ANAEROBIC REACTOR
For the pretreatment of high strength wastewater or for biological phosphorus removal in tertiary treatment.
EXCESS SLUDGE REMOVAL AND SLUDGE RECIRCULATION
OPEN AEROBIC REACTORS II-IV
Depending on the quality of the wastewater stream biological nitrification takes place in the consecutive aerobic stages. As the wastewater flows through each stage, its strength is reduced and higher organisms take part in the treatment process. In addition to plants, animals such as snails, otters crabs and fish can be found in the tanks towards the end of the treatment line.
INFLUENT
CLOSED AEROBIC REACTOR
The first phase of aerobic treatment for high strength waste with a built-in biofilter for odor removal
ANOXIC REACTOR
For pretreatment and nitrogen removal via denitrification in tertiary treatment

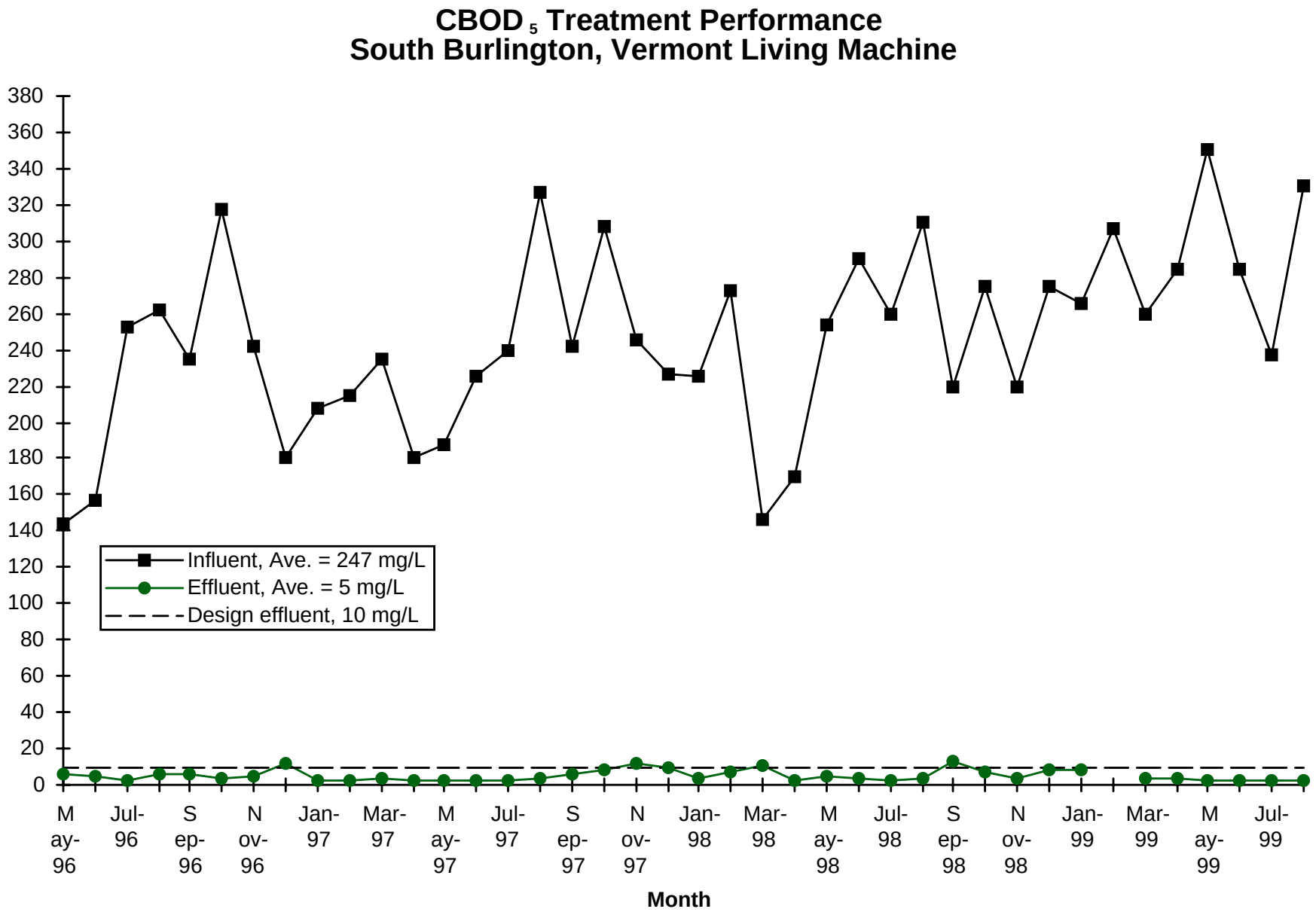


South Burlington
Municipal Wastewater Treatment System


9A

TSS Treatment Performance
South Burlington, Vermont Living Machine




CBOD 5 Treatment Performance
South Burlington, Vermont Living Machine
380
360
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Influent, Ave. = 247 mg/L
Effluent, Ave. = 5 mg/L
Design effluent, 10 mg/L
May-96
Jul-96
Sep-96
Nov-96
Jan-97
Mar-97
May-97
Jul-97
Sep-97
Nov-97
Jan-98
Mar-98
May-98
Jul-98
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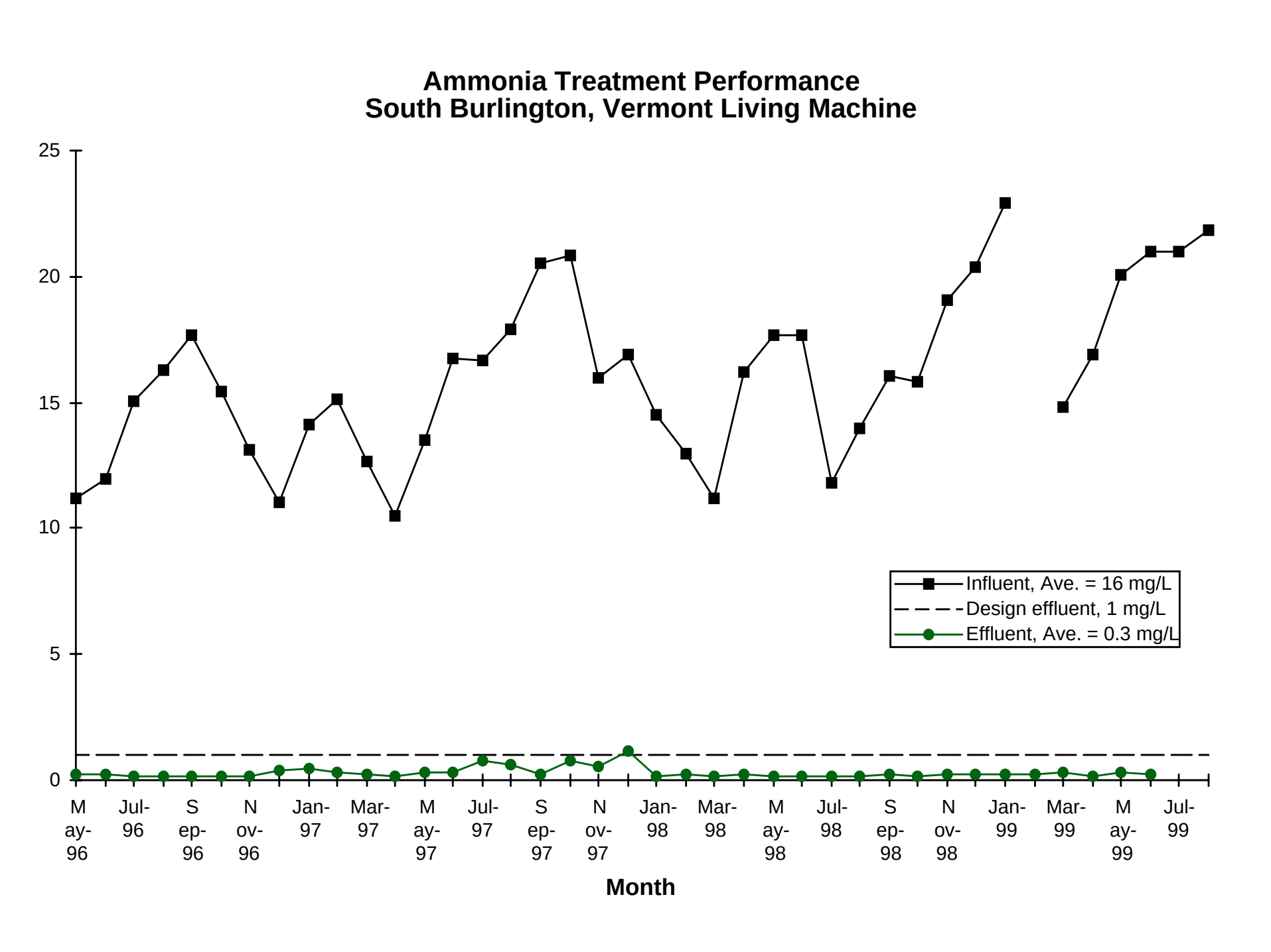
Nov-98
Jan-99
Mar-99
May-99
Jul-99
Month

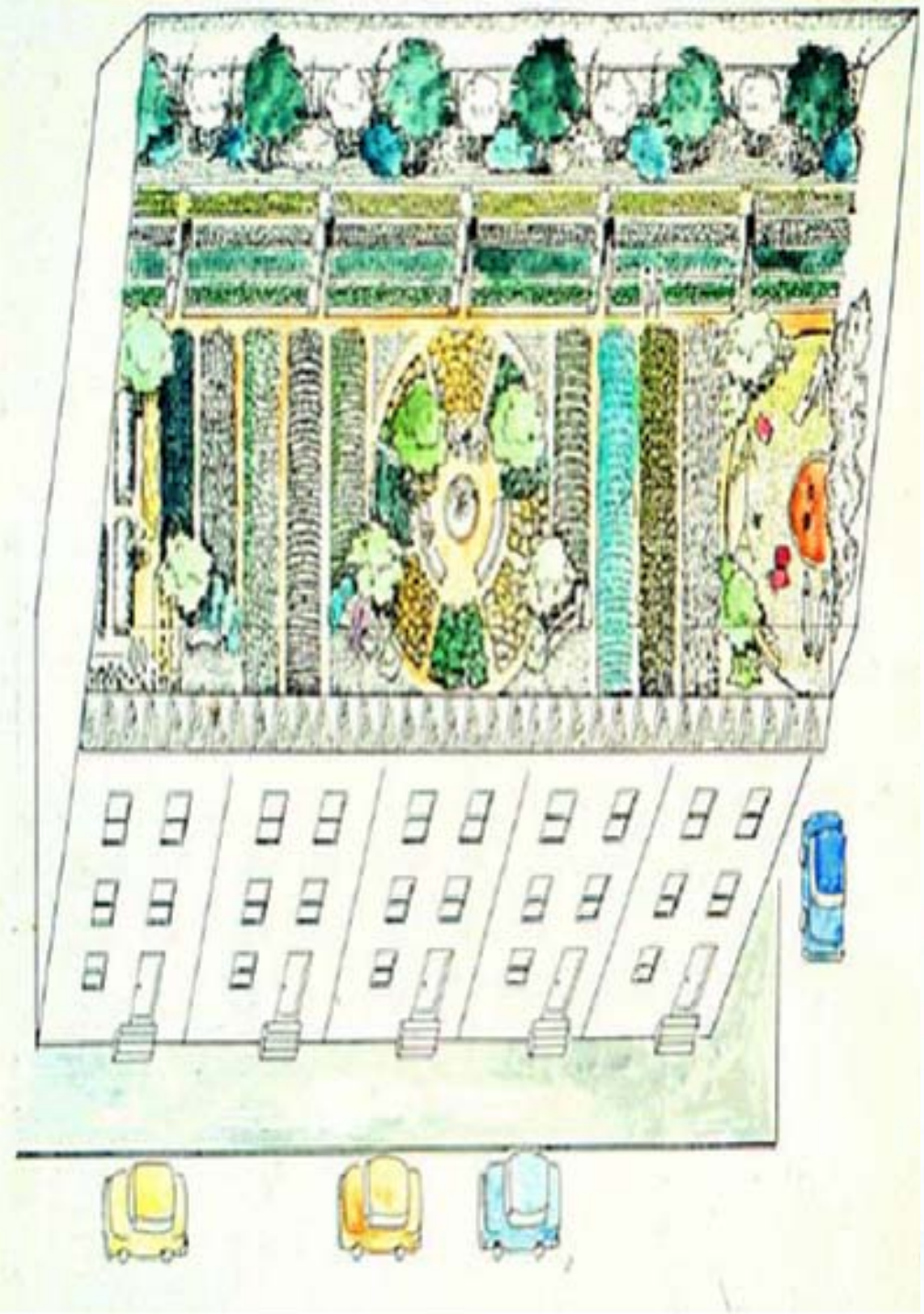

Ammonia Treatment Performance
South Burlington, Vermont Living Machine
25
20
15
10
5
0
Influent, Ave. = 16 mg/L
Design effluent, 1 mg/L
Effluent, Ave. = 0.3 mg/L
May-96
Jul-96
Sep-96
Nov-96
Jan-97
Mar-97
May-97
Jul-97
Sep-97
Nov-97
Jan-98
Mar-98
May-98
Jul-98
Sep-98
Nov-98
Jan-99
Mar-99
May-99
Jul-99
Month

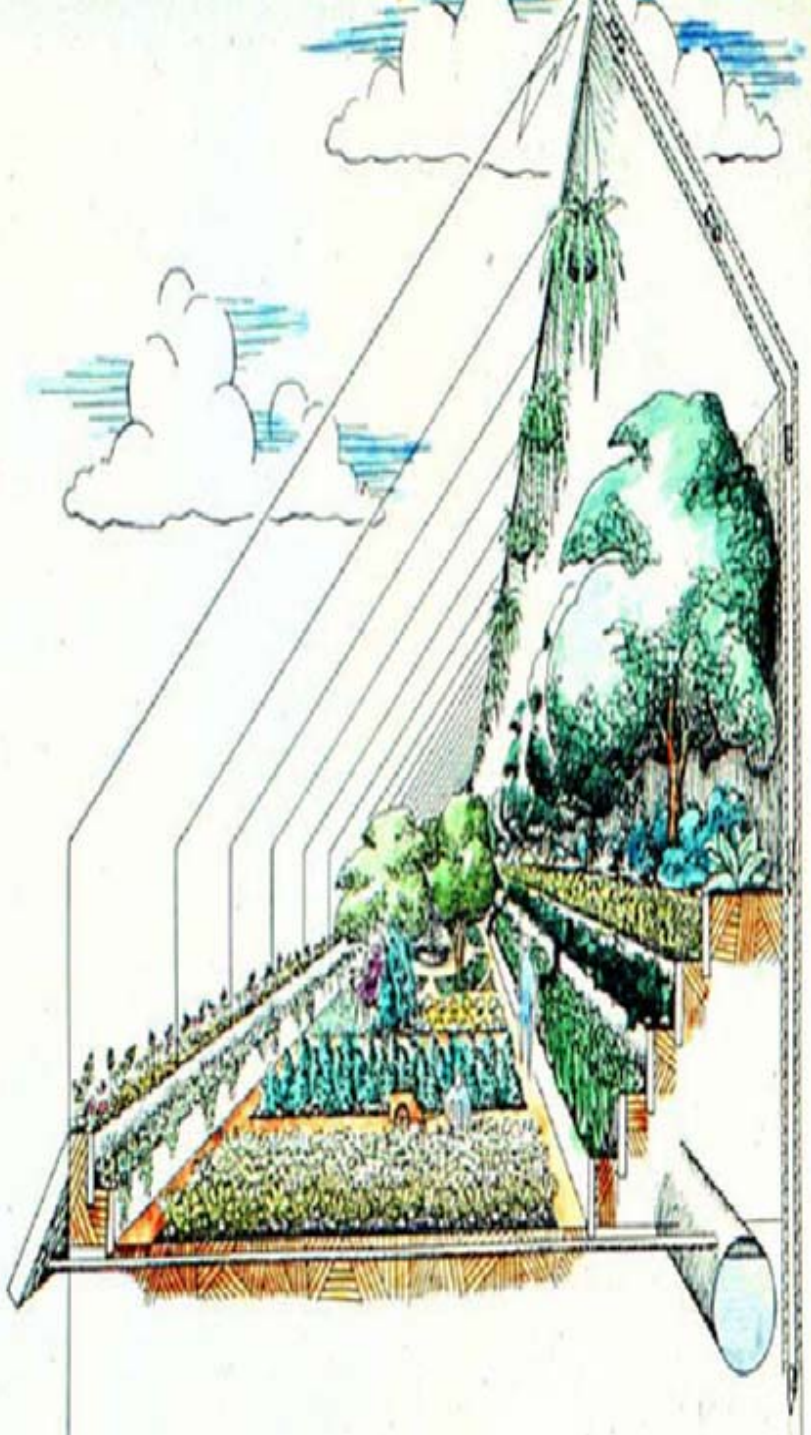
OCEAN ARKS INTERNATIONAL

Chattanooga Bench Top Experiment - MASSES

Parameter	ug CREEK SEDIMENT Day 0	ug ECO 1 SEDIMENT Day 60	ug ECO 2 SEDIMENT Day 60	ug ECO 2 LIQUID Day 60	ug REMOVAL	% MOVAL
2,4-Dimethylphenol	414.0	<10.1	<1.2	<1.2	401.5	97.0
4-Nitrophenol	60720.0	<59.2	<1.2	<7.2	60652.4	9919
Phenol	110.4	<10.1	<1.2	<1.2	97.9	88.7
1,4 Dichlorobenzene	331.2	<10.1	<1.2	<1.2	318.7	96.1
1,2,4-Trichlorobenzene	59.3	<10.1	<1.2	<1.2	46.9	79.0
Napthalene	20700.0	7104.0	91.0	<1.2	13503.8	65.2
Acenapthene	37250.0	15392.0	406.0	<1.2	21460.8	57.6
Fluorene	41400.0	17168.0	420.0	<1.2	23810.8	57.5
Anthracene	31740.0	<10.1	<1.2	<1.2	31727.5	100.0
Fluoranthene	52440.0	7696.0	3080.0	<1.2	41862.8	79.4
Pyrene	34500.0	<10.1	<1.2	2.0	34486.8	100.0
Benzylbutylphthalate	42.8	<10.1	<1.2	<1.2	30.3	70.8
Benzo(a)anthracene	24840.0	<10.1	<1.2	1.5	24826.3	99.9
Benzo(a)pyrene	11316.0	<19.5	<1.2	<2.4	11292.9	99.8
Indeno(1,2,3 cd)pyrene	9384.0	<19.5	<2.3	<2.4	9359.8	99.7
Dibenzo(a,h)anthracene	9384.0	<19.5	<2.3	<2.4	9359.8	99.7
Benzo(ghi)perylene	6762.0	1776.0	343.0	<2.4	4640.6	68.6
Aldrin	692.8	29.6	6.3	<.002	656.9	94.8
alpha-BHC	690.0	51.5	6.3	<.002	632.2	91.6
P'P"DDT	125.6	<5.9	<0.7	<.002	119.0	94.8
P'P"DDE	74.5	11.8	2.1	<.002	60.6	81.3

Educational Living Laboratories





To review:

- In addressing waste, soil, biology *and* life it makes sense to think in terms of cycles:
  - Waste cycle: trees → pogo tree experts → biomass reduction → mulch and compost → trees
  - Soil life cycles: succession, food web, balanced biology/nutrients. bacteria → protozoa →nematode → plant → bacteria
  - Cultural/environmental cycles of change: remediate damage for sustainability (toxic water, soil, erosion) → learning experience → sustainable culture that stewards/experience/ interacts with the → sustainable environment

Thank you
for your time and consideration