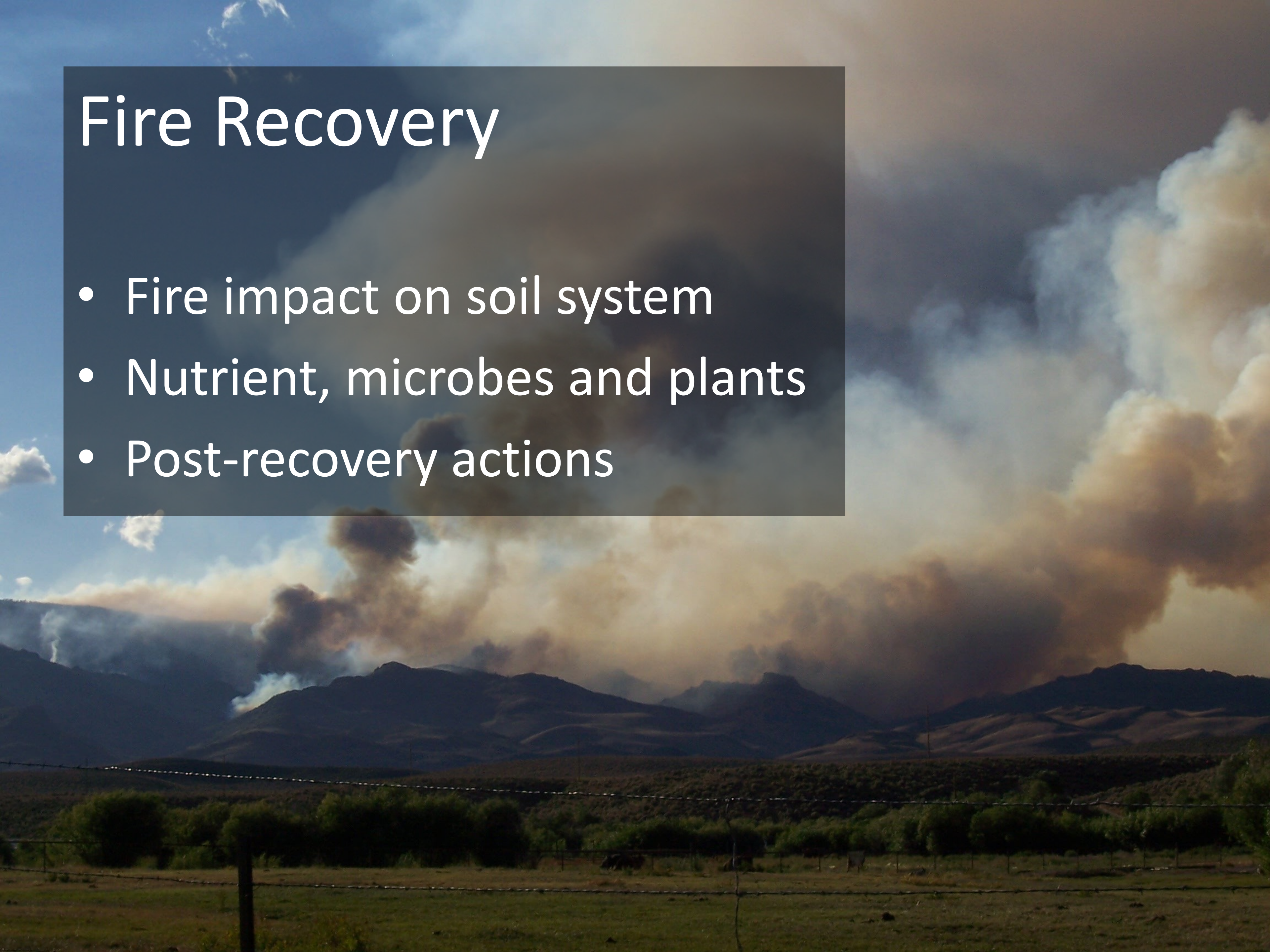
Fire Recovery

- Fire impact on soil system
- Nutrient, microbes and plants
- Post-recovery actions



The paradigm of regeneration

Out of Control	Response - ability
Seek control	See personal responsibility
Stress, worry, anxiety	Choose your attitude
Blame- weather, politics, family…	Work on realm of influence
I am my upbringing and circumstances	My life is not my past
I can't- excuses	How can I? … actions
A focus on Doing	A focus on Being
Separate	Part of a whole

Three key areas for recovery from natural disasters:

- Human resources
- Natural resources
- Financial resources

Achieving goals

Farmers who manage these 3 key areas proactively are more resilient to disasters and better able to manage the recovery process to achieve a good outcomes.

Natural resources

- How does fire affect soil and plant recovery?

Tingha Fires Jan 2019

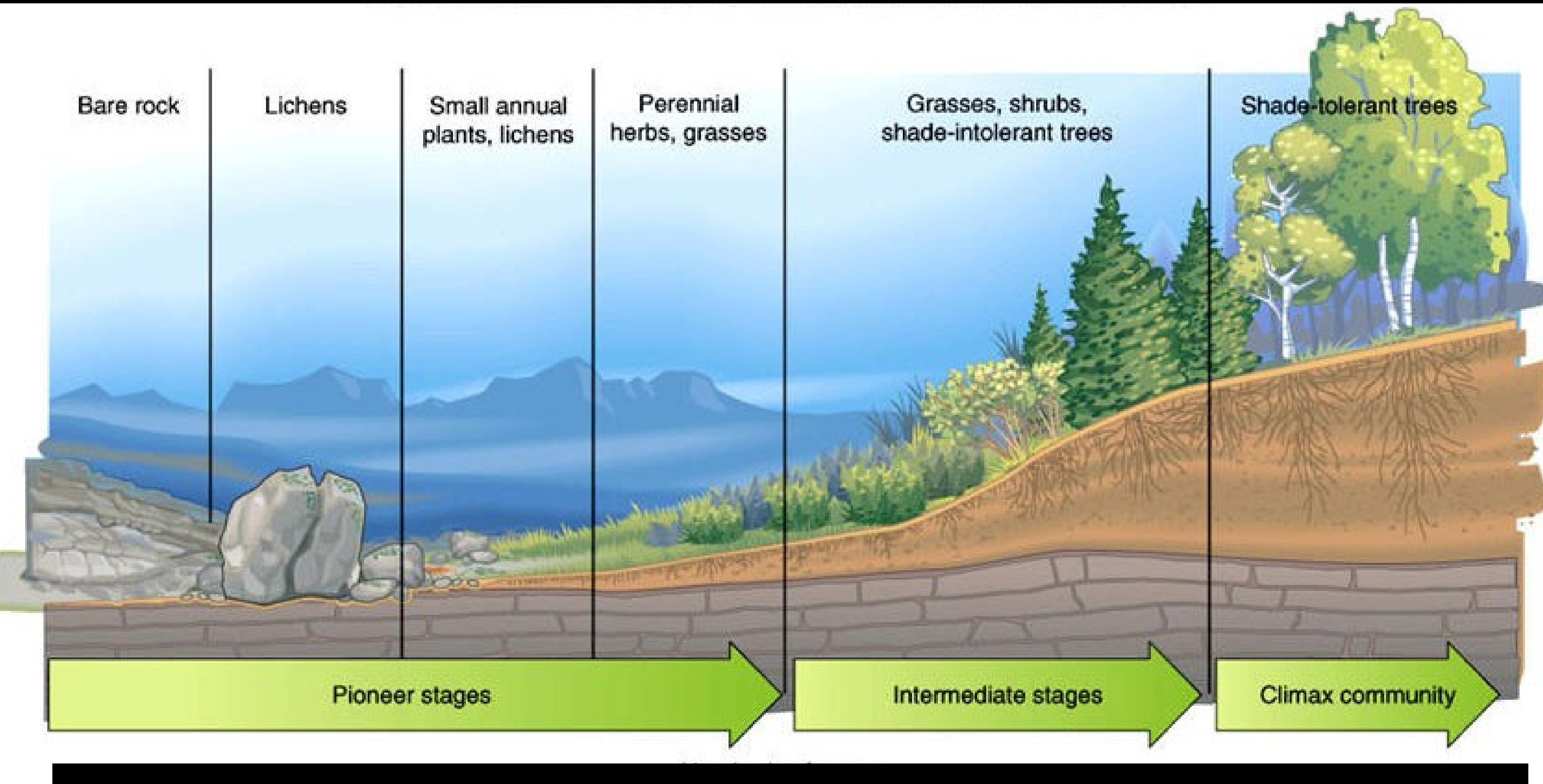
Kim and Angus Deans

Kubler Ross
stages of grief

- 1^{st} stage: denial and isolation
- 2^{nd} stage: anger
- 3^{rd} stage: bargaining
- 4^{th} stage: depression
- 5^{th} stage: acceptance

....Hope

Kim Deans



Bacterial dominated

B:F balance

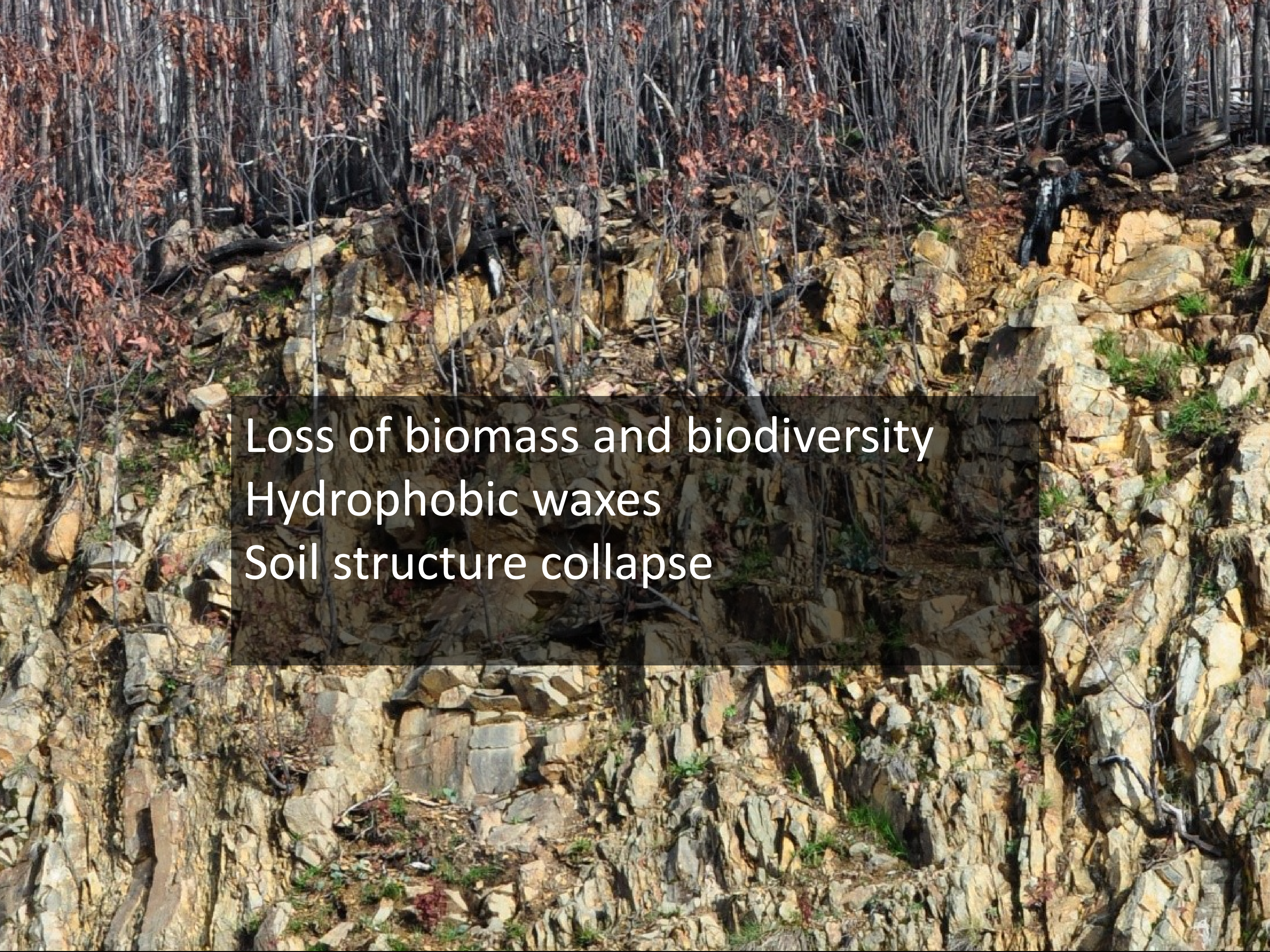
Fungal dominated

Fire impacts and recovery times dependant on fire duration and temperature

- 1-11 years microbial populations
- >80 years for full soil ecosystem recovery

Fire impacts on soil

Loss of organic matter, increased pH and EC, increased erosion and nutrient and water cycle breakdowns


Loss of biomass and biodiversity
Hydrophobic waxes
Soil structure collapse

Mineral dynamics

- Reduction in total nutrients through; oxidation, volatilization, ash transport, leaching, inorganic lock-up, and erosion
- Anions more sensitive to fire; N, S & B
  - Short-term spike in N


Surface may be > 620^{o}C
Top 2 inches rarely exceed 148^{o}C
Below 25-30cm typically unaffected
Photo: USDA, Brad Rust

Microbial dynamics

- Loss in biodiversity and community structures
- 50% reduction in fungal diversity and abundance
- Reduction in N-cyclers

Bacteria and archaea

- Oldest, simplest, most numerous organisms
- Involved in: disease suppression, nutrient retention, form soil micro-aggregates


Bacterial dominance post fire creates:

- Fine aggregates/ compaction
- High bacteria and low predators tie up nutrients
- Germination signal for many “weeds”

Fungi

- Disease suppression
- Retain nutrients
- Decomposers
- Form soil <u>macro</u>aggregates
- Hold soils together
- Yield

Fungi are vulnerable to fire

- 50% drop in biomass following fires =
  - Increase erosion
  - Decrease in mineral uptake; Ca, P, trace elements
  - Decrease in water holding

(Dooley and Treseder, 2012)

Esposito, Giuseppe, et al. "Post-fire erosion response in a watershed mantled by volcaniclastic deposits, Sarno Mountains, Southern Italy." *Catena* 152 (2017): 227-241

Changes in diversity

Some bacterial and fungal species increase following fire:

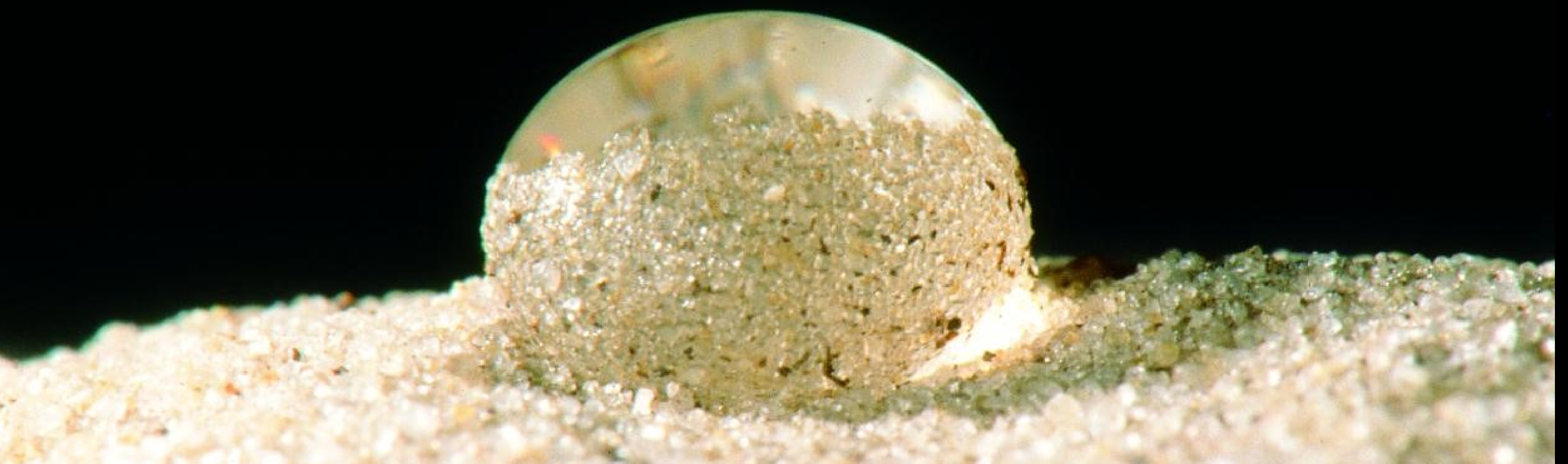
- Bacteria: *Massilia* and *Arthrobacter* genera
- Some fungi: *Penicillium* and *Fusicladium* (pathogens)

Hydrophobic soils

Soils become water repellent under extreme heat and under certain vegetation

Hydrophobic conditions

- By-products of organic materials
  - Aggregate around soil particles
  - Move through profile to form impervious layers
- Created by microbes



Managing hydrophobic soils

- Low rates of alkaline products
  - Liquid / fine limes
  - Milk
- Vermicast
- Seed dressings of the above inputs

Vermicast

- A vital fire recovery tool
- Contains biology and signals to kick-start soil rebuilding processes – the elixir of life!

Vermicast

- Contains microbes which EAT hydrophobic coatings;
  - *Pseduomonas flourenscens, Serratia marcescens and Baccilus spp*

Chemical contaminants

- Following the Californian fires researchers found nearly 2,000 chemical compounds
- heavy metals, copper, lead, arsenic, asbestos, transformer fluid, brake fluid, fire retardant, volatile organic chemicals such as benzene

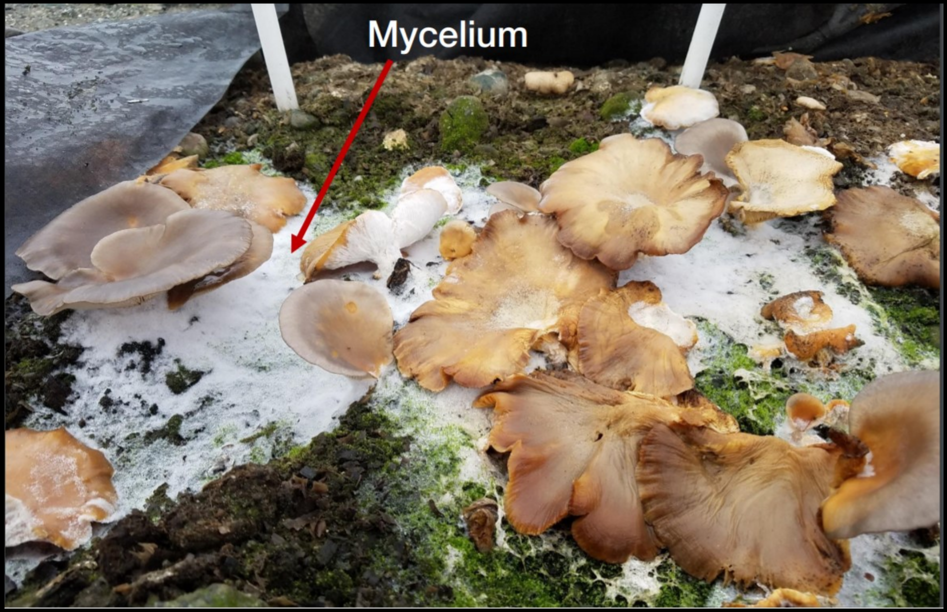
Phytoremediation

Plant remediation crops:

Oriental mustard, Hemp, willow/poplar, corn, sunflower

Mycoremediation

- Mushrooms have been used to clean up oil spills, heavy metals, DDT, toxins and uranium
- Oyster mushrooms most commonly used spp



Optimising biological diversity and biomass is critical

- Plant health and nutrition is driven by biological functions
  - More communities= more signals=more gene expression= increased crop health and resilience
  - Without community, full gene expression cannot occur!

Actions for remediation

Kick-start biological processes asap

Bio-stimulants

- Fish hydrolysate – provides bioavailable P, N, S and oils to stimulate fungi
- Liquid limes - feed biology, breakdown hydrophobic layers
- Molasses – feed bacteria, kick start life

Soil Program post fire:

7 litres fish
1 litre Molasses
15 ltr Liquid lime

Post treatment
5% plant yield recovery in control
vs 74% in treatment

(Dr Peter Espie, AgScience)

Generic recipe

Application	Rate Ha
Fish Bio-Stimulant	10 ltr
Molasses/liquid sugar	500 mls
Vermliquid	5 litres
Liquid Lime	25 litres
Humic Acid	1 litre

- Fungal diverse compost/extracts
- Vermicast/vermiliquid - microbially balanced

Living roots

- Diverse annual cover crop species to kick start
  - Must address water repelancy and low microbial communities
  - Use seed dressings
  - Many species as possible > 8
  - Untreated seed!

Whole systems approach

- Create environment for plant recovery
- Address water infiltration
  - Chemical or physical restraints
  - If using mechanical interventions, FEED microbes!
- Plants build soil
  - Support optimal plant health, seed dressings

Actions

- In an area that was burnt, do the infiltration test, if water isn’t going in faster than 2mm/min is there an action you can take?
- Set up an experimental plot using oyster mushrooms

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INTEGRITY SOILS

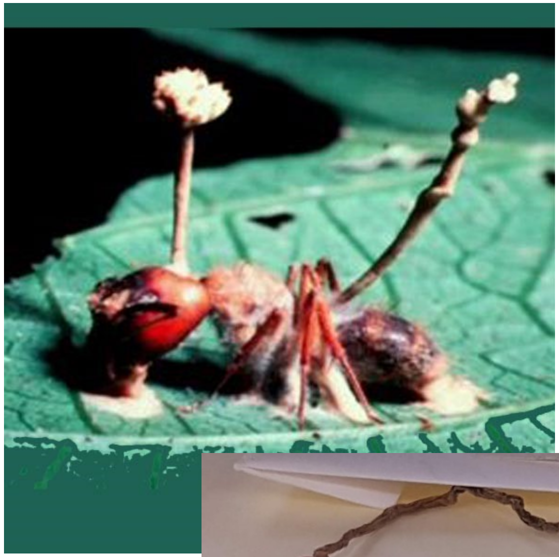
Building Natural Capital

Slides for session 2 with Far East Landcare

Insect and disease pressures are related to soil health and nutrition

When feeding on high brix & complete proteins

- reduced ability to breed, fewer eggs and juveniles are smaller



Soil microbes for pest/disease suppression

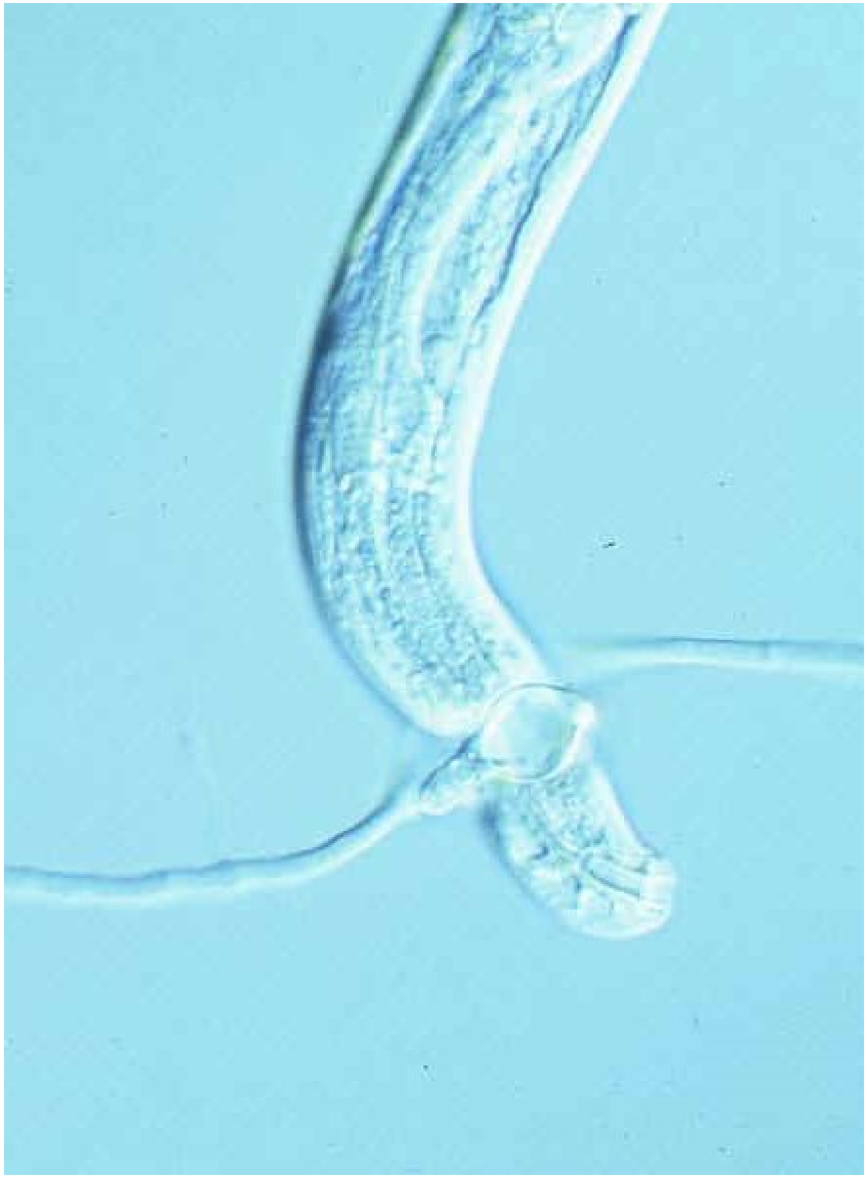
Biocontrols

1. Entomophathagenic Fungi; e.g. *Beauvaria Bassiana* and *Metarhizium anisopliae*
2. Free-living soil microbes, such as *Trichoderma*, *Yersinia* or *Bacillus*
3. Entomopathogenic nematodes;
4. Viruses, such as *Baculovirus*;

Biocontrols

5. Arthropod predators; and
6. Plant endogenous defences and priming.

Also Nemataphage – fungi which catch nematodes.

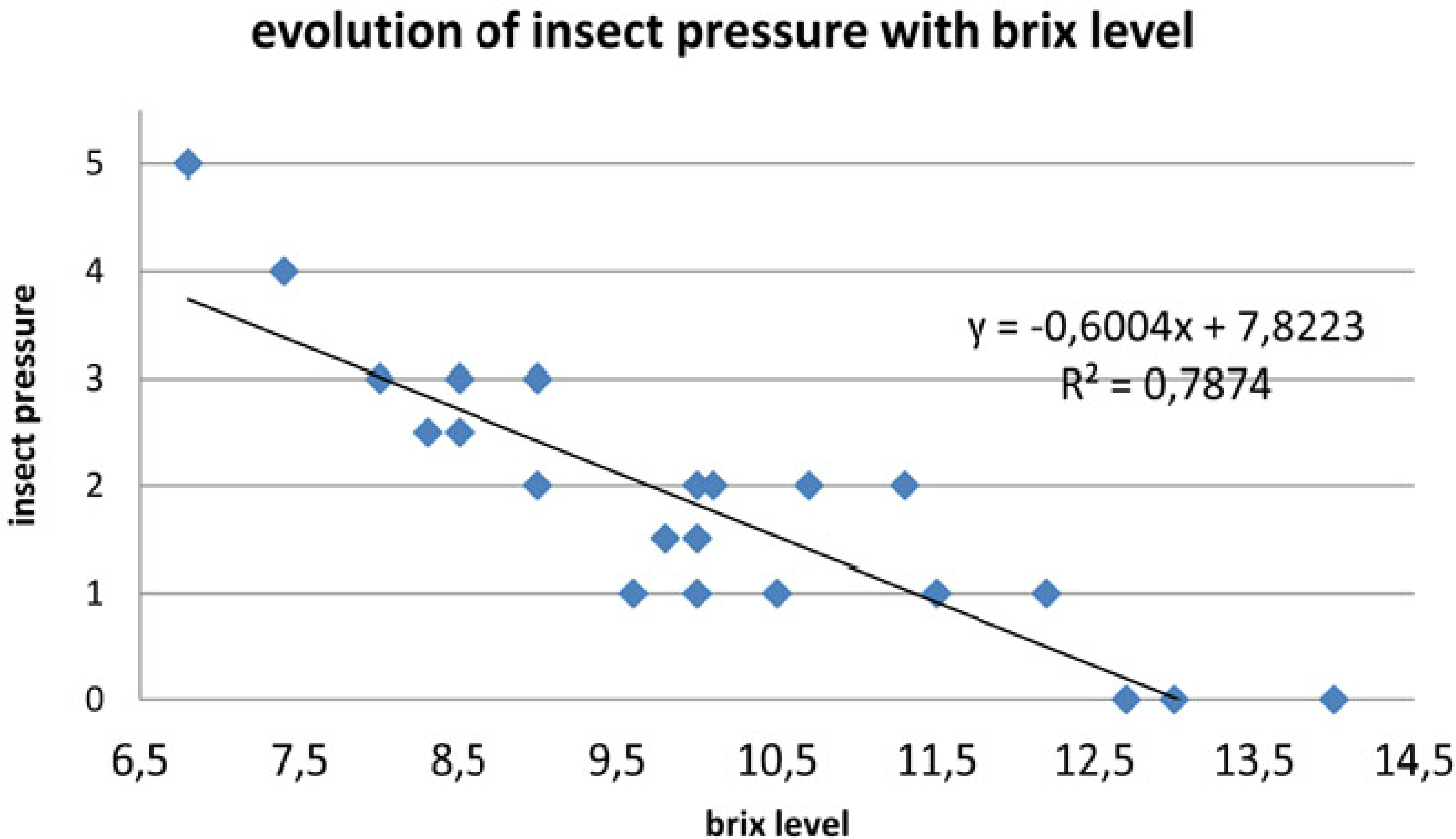


These are available as packaged products

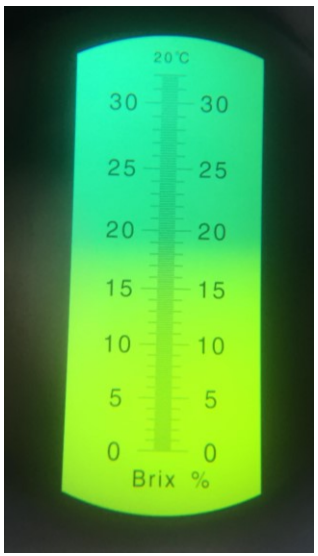
Use as a runway transitional tool

They are <u>NATURALLY in HEALTHY SOIL</u>

Graph taken from 30 farms in Manuwatu and HB.
Florent 2010, Outgro Study



Nutrition for plant defence



- Complex amino acids;
  - biological foods, humic substances, cover crops
- Lift brix
- Build soil health!

Biology and insect pests/disease

- Insect and disease pressures are directly and indirectly related to soil health and nutrition.
- Insects are attracted to incomplete proteins- free amino acids.
- They avoid complete protein, high brix food
  - reduces their ability to breed, lay less eggs and juveniles are smaller

Abawi &Widmer (2000). Bailey & Lazarovits (2003), Čatská.,V. (2008), Gurr et al, (2012), Hill (2004), Chau & Heong (2005), Hoorman, (2009)

Unintended consequences of pesticides and fungicides

- Reduce secondary metabolites necessary for plant defence; such as salicylic and jasmonic acid.
- Reduce mycorrhizal colonization and plant growth promoting organisms in rhizosphere
- Immunosuppressant for beneficial insects
- Reduce plant brix, increase free amino acids and change the plant phenolics used for plant defence.

Szczepaniec, A., Raupp, M. J., Parker, R. D., Kerns, D., & Eubanks, M. D. (2013). Neonicotinoid insecticides alter induced defenses and increase susceptibility to spider mites in distantly related crop plants. *PloS one*, *8*(5), e62620.

Bohlen, P. J., & House, G. (2009). *Sustainable agroecosystem management: integrating ecology, economics, and society*. CRC Press.

Abduallah, Gamal. (2017). Efficiency and side effects of three neonicotinoid insecticides used as faba bean seed treatments for controlling cowpea aphid. Egyptian Scientific Journal of Pesticides.