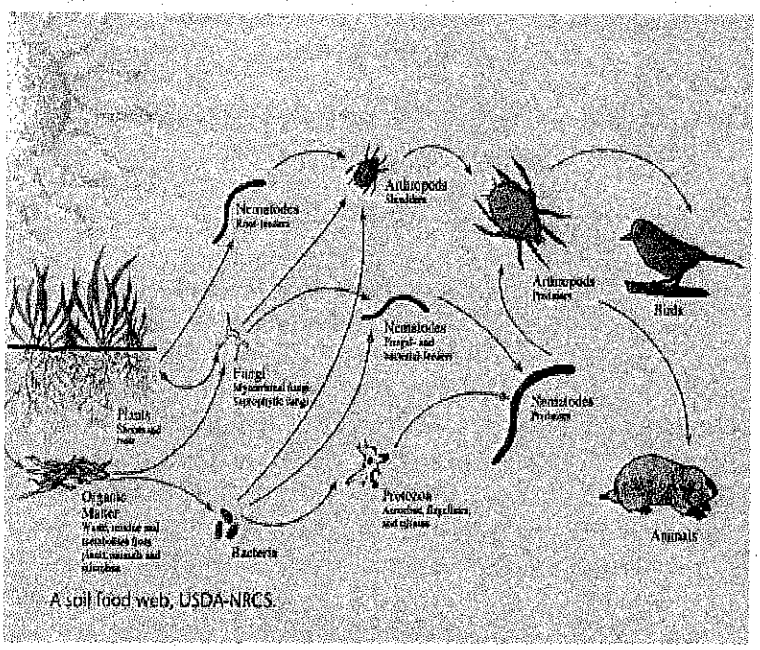
Soil Quality - Biological Indicators

(see Key Point 2 – Learning Objectives, Soil Ecosystems Envirothon Curriculum Guidelines, last update 01/01/12)

OVERVIEW OF SOIL ORGANISMS (see soil food web) – Note role of Bacteria, Fungi & Earthworms



A soil food web, USDA-NRCS.

What do earthworms do? They dramatically alter:

- **soil structure** : generate tons of castings/acre/year
- **nutrient dynamics:** increases microbial activity affecting N/P levels through presence in feces/castings.
- **plant growth:** increase movement of minerals/nutrients to lower soil strata.
- **infiltration:** castings enhance porosity & tunnels create areas for water drainage
- **increased water capacity of soil** – worms fragment organic matter thus increasing soil porosity through an increased soil surface area
- **channels for root growth:** lined with readily available nutrients, easier root penetration in soil.
- **shred plant residue:** aids decomposition and transport of plant material with tunneling action.

12 Indicators to Measure Soil Quality in a Field – see how earthworms affect these factors!

Note difference in picture between cabbages in natural soil and soil with worm castings in picture

(Source URL: http://cornandsoybeandigest.com/twelve-indicators-measure-soil-quality, downloaded 1/19/2013)

1. Presence of earthworms (note graph in USDA NRCS article)
2. Presence of organic matter
3. Organic residues (worm castings)
4. Degree of Subsurface compaction
5. Soil tilth/mellowness aka friability
6. Soil texture – crumbles well/slices easily/spongy
7. No gullies/no apparent soil runoff
8. Ability to hold water/for long periods without signs of drought
9. No ponding/runoff from normal rainfall
10. Crop color – healthy dark green throughout season
11. Soil pH aligns with crop growth
12. Nutrient soil capacity

Worm Populations and Grassy areas/Pastureland

How: Take a shovel full of earth from top foot of soil and take a quick count.

When: Best in spring/fall, ok during summer

Current thinking: 10 earthworms/shovel – good indicator

Reference: Building Soils for Better Crops (2012) Sustainable Agriculture Research and Education (SARE), USDA. Note: free downloadable version!) This reference contains case studies of farmers from across the country by sharing inspiring examples of how soil—and whole farms—have been renewed through these techniques. A must-read for farmers, educators and students.

WormWatcher *For further worm composting information, products, and lesson plan/activities, call*

Regina Ridgway Bundy regina@wormwatcher.com 757-256-3489

Soil Quality Indicators

Earthworms

Earthworms are native to non-glaciated areas of North America, but non-native species from Europe and Asia also exist here. Earthworms are classified into three groups based on their habitat. Litter-dwellers live in the litter, ingest plant residues, and may be absent in plowed, litter-free soil. Mineral soil-dwellers live in topsoil that is rich in organic matter. They burrow narrow channels and feed on a mixture of soil and plant residues. Deep soil-burrowers (night crawlers) dig long, large burrows into deep soil layers. They carry with them plant residues for consumption. Earthworm cast is digested material that is excreted back into the soil. Cast is enriched with nutrients (N, P, K, and Ca) and microorganisms during its passage through the worm's digestive system. Fresh cast is a site of intense microbial activity and nutrient cycling. Earthworms contribute nutrients to the soil and improve porosity, tilth, and root development. They are measured in number/m^2.

Factors Affecting

Inherent - Earthworms are found in various environments, but seasonal and climactic variations affect their abundance, distribution, and activity. They are most active in the spring and autumn. Soil moisture, aeration, temperature, and texture affect earthworm populations. Water makes up more than 75% of the earthworm's body weight, so moist soils are preferred to prevent dehydration. Earthworms acclimate quickly by moving to humid sites or by entering a resting state. In the absence of mulch, very high or freezing soil temperatures can drastically reduce earthworm populations in a short time, but the lethal temperature is variable among species. A generalized range for earthworm activity is 32 – 86 degrees F. Stable aggregates contain organic matter and improve porosity, consequently improving air circulation, drainage and infiltration, which favor earthworm establishment.

Silty soils with high water holding capacity and organic matter provide ideal habitat for earthworms compared to sandy soils, which have lower organic matter content and water holding capacity, and dry and reach uncomfortable temperatures quickly. Deep soils are the favorite niche for earthworms, especially shallow soil-burrowers.

Dynamic - Earthworm abundance and activity trend with the amount and quality of plant residues, which provide food and mulch for habitat. Mulch helps maintain soil moisture and moderates soil microclimate, providing adequate time for earthworms to migrate and escape high or freezing temperatures. No-till and other conservation practices create ideal conditions for earthworms. The population in no-till fields can reach two to three times that in conventionally tilled fields (fig. 1). Populations of litter-dwellers and night crawlers may drop and even vanish in conventional tillage systems because of the destruction of burrows and depletion of surface residues. Earthworm populations are generally high and active in grassland due to the thick surface cover and continuous supply of food from residues and animal wastes.

While neutral pH is ideal, earthworms can adjust to pH 5–8 with some species tolerating even more acidic soils. Oxygen requirements also vary among species with some tolerating low amounts. Ammonia and ammonia-based fertilizers are toxic to earthworms due to acidic conditions created by their use. Herbicides tend to have low toxicity to earthworms if used at the recommended rate, especially when applied in bands. However, atrazine, which is widely used, is reported to be slightly toxic. Carbamate insecticides (table 1) and fungicides (carbendazim, benomyl) have severe adverse effects on earthworms.

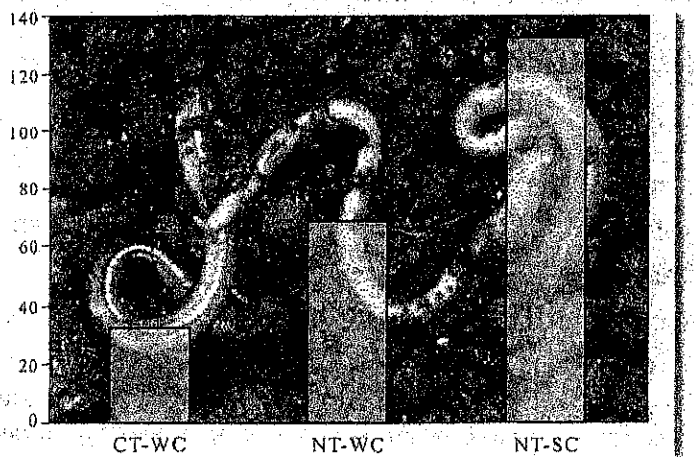


Figure 1. Effect of tillage and crop on earthworm number/m^2 CT=conventional till, NT= no-till; W=wheat, C=corn, S=soybean Adapted from Hubbard, et al. 1999.