Chapter #20 – Ecosystem Energetics

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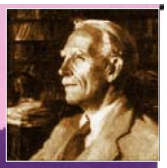
20.1 – The Laws of Thermodynamics Govern Energy Flow.
20.2 – Energy Fixed in the Process of Photosynthesis is Primary Production.
20.3 – Temperature, Water, and Nutrients Control Primary Production in Terrestrial Ecosystems.
20.4 – Temperature, Light, and Nutrients Control Primary Production in Aquatic Ecosystems.
20.5 – Energy Allocation and Plant Life Form Influence Primary Production.
20.6 – Primary Production Varies With Time.
20.7 – Primary Production Limits Secondary Production.
20.8 – Consumers Vary in Efficiency of Production.
20.9 – Ecosystem Have Two Major Food Chains.
20.10 - Energy Flow Through Trophic Levels Can Be Quantified.
20.11 - Consumption Efficiency Determines the Pathway of Energy Flow Through the Ecosystem.
20.12 - Energy Decreases in Each Successive Trophic Level.

An "Ecological System?"

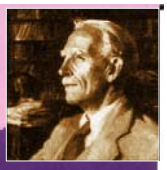


Sir Arthur Tansley (1871-1955)

In the discipline of ecology, the word Ecosystem is an abbreviation of the term, **ecological system – the basic unit in ecology.** It first appeared in a 1935 publication by the British ecologist Arthur Tansley (Tansley, 1935). However, the term had been coined already in 1930 by Tansley's colleague Roy Clapham, who was asked if he could think of a suitable word to denote the physical and biological components of an environment considered in relation to each other as a unit.

Tansley, A., 1935, The use of vegetational concepts and terms. Ecology, v. 16, p. 284-307.

An "Ecological System?"



Sir Arthur Tansley (1871-1955)

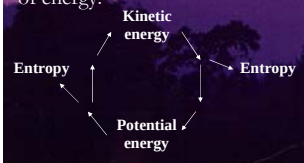
Components of an Ecosystem:

Biotic Components	Abiotic (non-living) and Physical Components
Species	Water
Populations	Nutrients
Communities	Topography
	Weather
Competition and Predation	Disturbances

Energy and the Laws of Thermodynamics

20.1 – The Laws of Thermodynamics Govern Energy Flow.

Energy exists in many forms, such as heat, light, chemical energy, and electrical energy. **Energy is the ability to bring about change or to do work.** Thermodynamics is the study of energy.



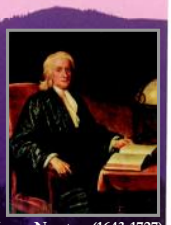
Energy and the Laws of Thermodynamics

The 1st Law of Thermodynamics: Energy can be changed from one form to another, but it cannot be created or destroyed. The total amount of energy and matter in the Universe remains constant, merely changing from one form to another.

Isaac Newton (1643-1727)

Energy and the Laws of Thermodynamics

The 2nd Law of Thermodynamics: "*in all energy exchanges, if no energy enters or leaves the system, the potential energy of the state will always be less than that of the initial state.*" In energy transfer, some energy will dissipate as heat. The flow of energy maintains order and life.



Isaac Newton (1643-1727)

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20.2 – Energy Fixed in the Process of Photosynthesis is Primary Production.

Global Primary Productivity

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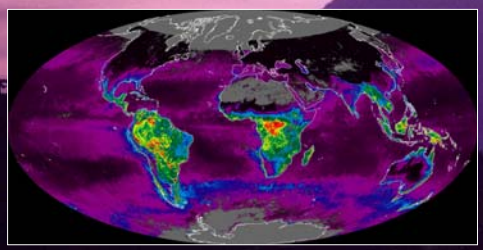

Global Primary Productivity

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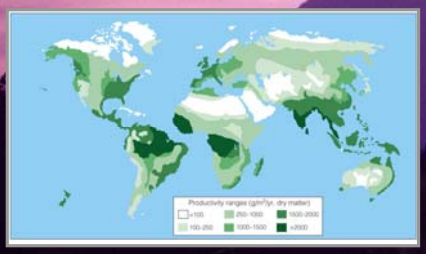

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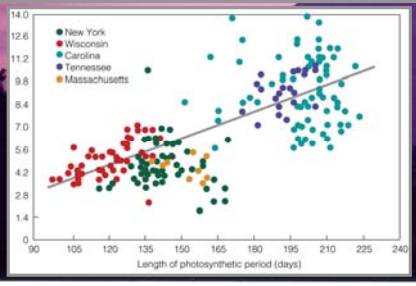
20.3 – Temperature, Water, and Nutrients Control Primary Production in Terrestrial Ecosystems.



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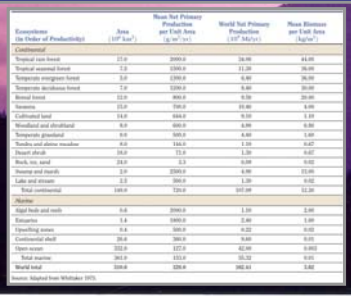
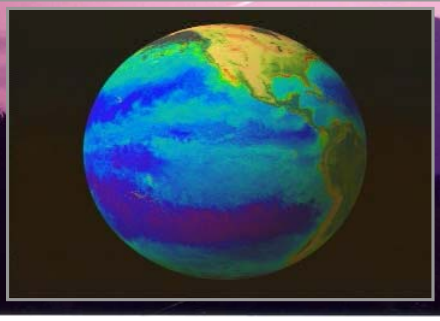


Global Primary Productivity

20.4 – Temperature, Light, and Nutrients Control Primary Production in Aquatic Ecosystems.



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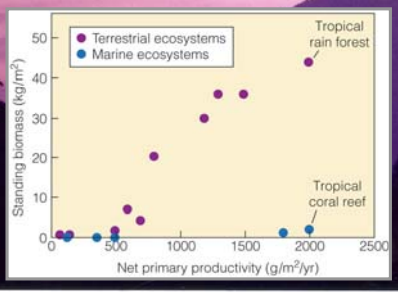
20.5 – Energy Allocation and Plant Life Form Influence Primary Production.



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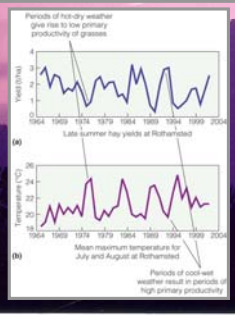
20.6 – Primary Production Varies With Time.



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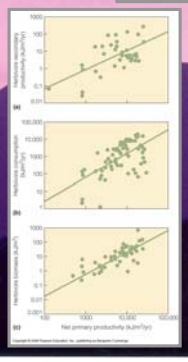
20.7 – Primary Production Limits Secondary Production.

The energy left over from maintenance and respiration goes into production, including both the growth of new tissues and production of young. This is called **secondary production**. Secondary productivity is greatest with the birthrate and the growth rate of individuals are highest.



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20.8 – Consumers Vary in Efficiency of Production.

Table 20.2 Production Efficiency ($P/A \times 100$) of Various Animal Groups

Group	P/A (%)
Mice	4.10
Voles	2.63
Other mammals	2.92
Birds	1.26
Fish	9.74
Social insects	8.31
Orthoptera	41.67
Hemiptera	41.90
All other insects	41.23
Mollusca	21.59
Crustacea	24.96
All other non-insect invertebrates	27.68
Non-insect invertebrates	
Herbivores	18.81
Carnivores	25.05

Source: Data from Humphreys 1979.

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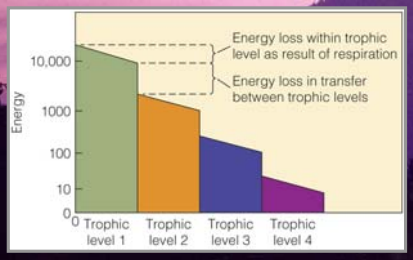
20.12 - Energy Decreases in Each Successive Trophic Level.



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