GREEN TECHNOLOGY

Lecture Plan

Week	Topic will cover	Topic covered	Remarks
1st	Introduction to nexus between Energy, Environment and Sustainable Development; Energy transformation from source to services; Energy sources,		
2nd	sun as the source of energy; biological processes; photosynthesis; food chains, classification of energy sources, quality and concentration of energy sources;		
3rd	Fossil fuel reserves - estimates, duration; theory of renewability, renewable resources; overview of global/ India's energy scenario.		
4th	The inseparable linkages of life supporting systems, biodiversity and ecosystem services and their implications for sustainable development; global warming;		
5th	greenhouse gas emissions, impacts, mitigation and adaptation ; future energy Systems- clean/green energy technologies;		
6th	International agreements/conventions on energy and sustainability - United Nations Framework Convention on Climate Change (UNFCC); sustainable development;		
7th	Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Green Composites for buildings:		
8th	MSE		
9th	Concepts of Green Composites. Water Utilization in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage.		
10th	Urban Environment and Green Buildings. Green Cover and Built Environment. Green roads and its construction procedure.		
11th	Introduction to Green Chemistry: Principles of Green Chemistry, Reasons for Green Chemistry (resource minimization, waste minimization, concepts),		
12th	Green reactions solvent free reactions, Catalyzed (heterogeneous/homogeneous) reactions, MW/ Ultrasound mediated reactions, Bio catalysts etc		
13th	Introduction to nanomaterial's: Nanoparticles preparation techniques, Nanomaterial's for "Green" Systems: Green materials, including biomaterials,		
14th	Biopolymers, bio plastics, and composites Nanotech Materials for Truly Sustainable Construction: Windows, Skylights, and Lighting. Paints, Roofs, Walls, and Cooling.		

UNIT 2: ENERGY SOURCES

- The inseparable linkages of life supporting systems,
- biodiversity and ecosystem services and their implications for sustainable development;
- global warming;
- greenhouse gas emissions,
- impacts, mitigation and adaptation ;
- future energy Systems-
- clean/green energy technologies;
- International agreements/conventions on energy and sustainability –
- United Nations Framework Convention on Climate Change (UNFCC); sustainable development;

The inseparable linkages of life supporting systems

WHAT IS TO BE SUSTAINED:	FOR HOW LONG? 25 years "Now and in the future" Forever	WHAT IS TO BE DEVELOPED:
NATURE Earth Biodiversity Ecosystems		**PEOPLE** Child survival Life expectancy Education Equity Equal opportunity
LIFE SUPPORT Ecosystem services Resources Environment	**LINKED BY** Only Mostly But And Or	**ECONOMY** Wealth Productive sectors Consumption
COMMUNITY Cultures Groups Places		**SOCIETY** Institutions Social capital States Regions

The inseparable linkages of life supporting systems

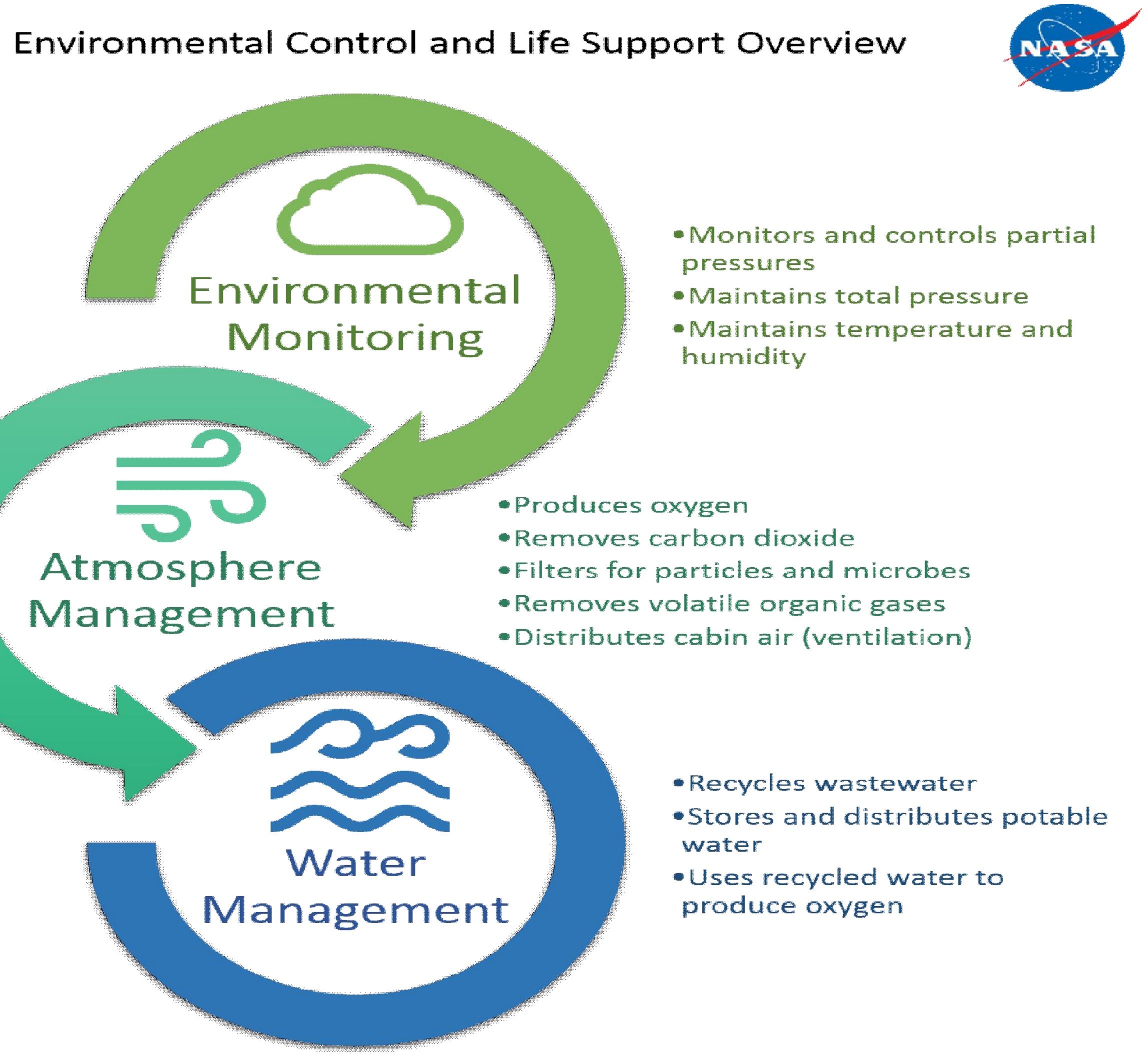
Are you using that resource unsustainably?

In what ways could you reduce, reuse and recycle that resource?

Is there an unequal distribution of this resource so that you are more fortunate than many others who have less access to it?

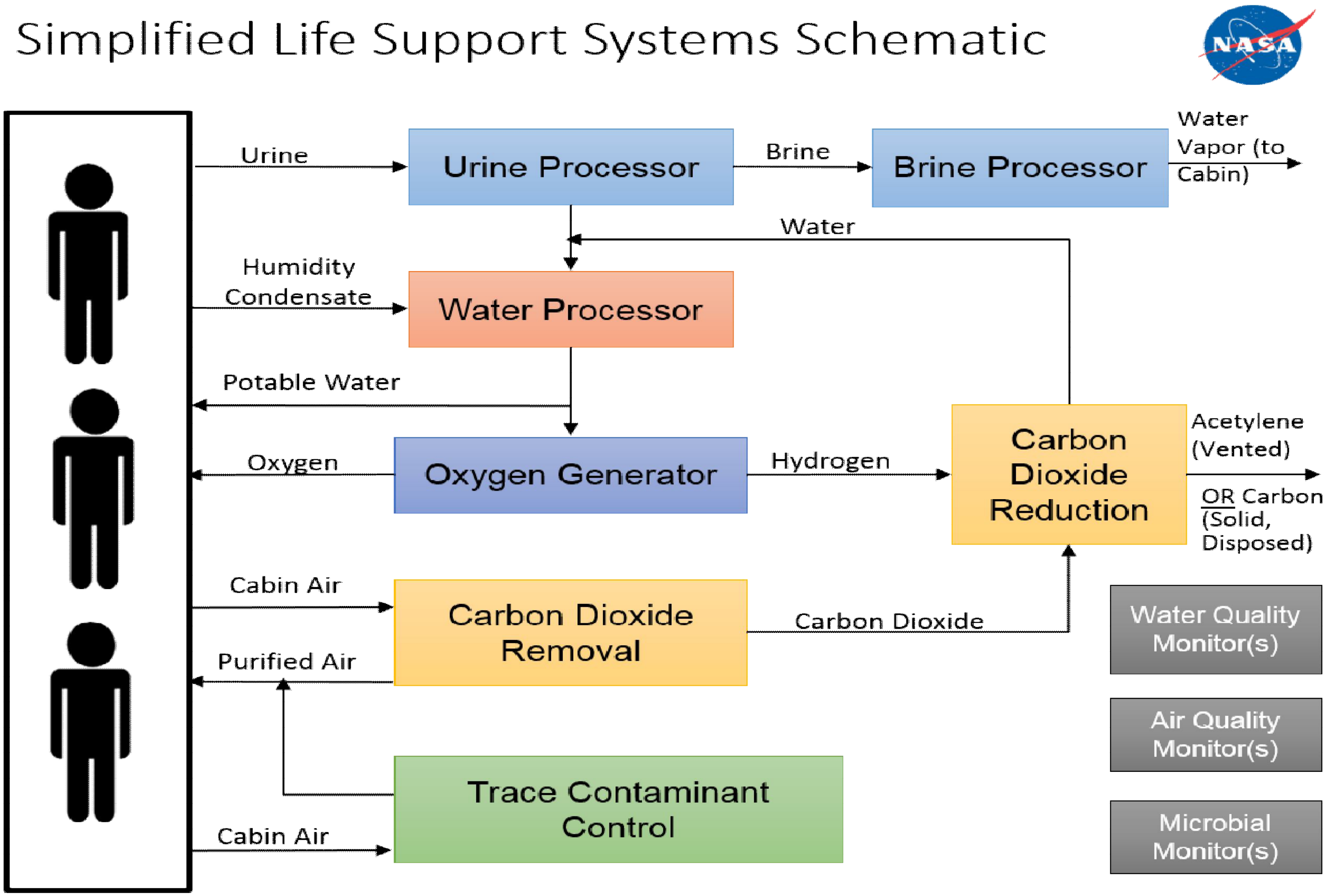
Once we begin to ask these questions of our-selves, we will begin to live lifestyles that are more sustainable and will support our environment.

The inseparable linkages of life supporting systems



Environmental Control and Life Support Overview diagram that includes three components: Environmental Monitoring, Atmosphere Management, and Water Management.
Credits: NASA

The inseparable linkages of life supporting systems



The Simplified Life Support Systems Schematic shows all of the elements of a life support system, including various processors for waste, air, and water.

Credits: NASA

Life Support Systems Sustaining Humans Beyond Earth

NASA's Life Support Systems (LSS) activities develop the capabilities to sustain humans who are living and working in space - away from Earth's protective atmosphere and resources like water, air, and food. This includes monitoring atmospheric pressure, oxygen levels, waste management, and water supply, as well as fire detection and suppression.

After forty years of development, LSS technologies have advanced a great deal but remain heavily dependent on Earth. Sending life-sustaining supplies 250 miles to the International Space Station (ISS) requires careful planning, and a robust international supply chain for delivery in one or two days after launch.

Life Support Systems Sustaining Humans Beyond Earth

Existing life support systems on the ISS provide oxygen, absorb carbon dioxide, and manage vaporous emissions from the astronauts themselves. Analysis of these systems allows NASA to identify areas where additional technology development is needed. Addressing any gaps will make life support systems more reliable and effective, which will lead to integrated testing on Earth and ISS in preparation for future human spaceflight missions deeper into the solar system. In the 2020s, humans will conduct proving ground missions in cislunar space, which lies between Earth and the Moon or its orbit. Demonstrating key capabilities like these advanced life support systems will enable future deep space missions.

Life Support Systems Sustaining Humans Beyond Earth

- SYSTEMS ARCHITECTURE
- ENVIRONMENTAL MONITORING
- ATMOSPHERE MANAGEMENT
  - Oxygen Generation and Recovery
  - Carbon Dioxide Removal
  - Trace Contaminant and Particulate Control
- WATER MANAGEMENT

Life Support Systems Sustaining Humans Beyond Earth

➢ SYSTEMS ARCHITECTURE

With so many complex systems comprising life support in space, it is important to understand the overall system requirements to ensure that all the components integrate well together and that ground testing is as representative of destination environments as possible.

Specifically in this area, we:

Define life support system architectures for different space mission classes.

Assess life support system technologies.

Perform life support systems integration.

Define and monitor life support system testing.

Develop an integrated life support system model that will be used to understand life support system dynamics and the potential impacts of new technology infusion.

Study reliability, maintenance, and crew time requirements of the state-of-the-art subsystems to understand which subsystems require technology development to meet exploration requirements.

Life Support Systems Sustaining Humans Beyond Earth

➢ ENVIRONMENTAL MONITORING

Spacecraft are enclosed spaces that usually contain complex machines in operation as well as science experiments and technology demonstrations. A problem with any one of these things can compromise the enclosed environment, causing it to become unsafe. While current environmental monitors aboard ISS will alert crew members and mission control when an emergency occurs, long-duration environmental health monitoring cannot take place on board the space station.

Right now, NASA sends archived environmental samples back to Earth as part of the long-term monitoring process. In order to alleviate the need to return these air and water samples from space for analysis, NASA is developing onboard LSS analysis capabilities. The overall approach to LSS systems architecture and engineering is a major step toward this goal. Future monitoring needs are being addressed by embracing modular integration of multiple sensing modalities, employing a combination of simple and rugged technologies, and using highly capable complex approaches where needed. Efforts in this area include:

Life Support Systems Sustaining Humans Beyond Earth

Efforts in this area include:

- Developing and demonstrating onboard analysis capabilities that will replace the need to return air and water samples to Earth for ground analysis.
- Incorporating Microelectromechanical Systems (MEMS) technologies to enable significant miniaturization over current systems, and selects elements offering both low resources and high reliability operation for affordability.
- Developing, demonstrating, and/or testing leading process technology candidates and systems architectures that will fill capability gaps or significantly improve efficiency, safety, and reliability.
- Demonstrating test articles (at various technology readiness levels) in a ground test facility under relevant flight conditions.

Life Support Systems Sustaining Humans Beyond Earth

- ## ATMOSPHERE MANAGEMENT

Maintaining the atmosphere within a habitat is the highest priority of any life support system, which is why atmosphere management is a critical function for all human exploration missions. Life support systems must not only supply oxygen and remove carbon dioxide from the atmosphere, but also prevent gases like ammonia and acetone, which humans emit in small quantities, from accumulating. Vaporous chemicals from science experiments are a potential hazard, too, if they combine in unforeseen ways with other elements in the air supply. Air revitalization includes oxygen generation and recovery, removal of carbon dioxide and control of trace contaminates and particulates.

Life Support Systems Sustaining Humans Beyond Earth

- ATMOSPHERE MANAGEMENT
  - Oxygen Generation and Recovery

The oxygen generation and recovery technology development area includes several approaches to supply oxygen to the crew, to recover oxygen from exhaled carbon dioxide, and to recycle the recovered oxygen back into the atmosphere. Current oxygen generation systems aboard the space station can generate or recover approximately 40 percent of required oxygen; for exploration missions this percentage must increase significantly. Specific tasks include:

- Advancing technologies for an oxygen delivery and supply system.
- Developing technologies to increase oxygen recovery.
- Advancing technologies for high-pressure, high-purity oxygen generation for exploration vehicles.

Life Support Systems Sustaining Humans Beyond Earth

➢ Carbon Dioxide Removal

A majority of the breathing air for astronauts is recycled within the spacecraft or habitat, and a key part of this process is the removal of exhaled carbon dioxide.

Carbon dioxide removal and associated air-drying development efforts are focused on improving the current technology on the space station as well as assessing and examining the viability of other emerging or alternate technologies.

Specific tasks include:

- Performing test scenarios to optimize performance.
- Screening alternative sorbents (materials used to absorb or liquids or gases) to determine the best candidate for a deep space carbon dioxide removal system.
- Testing new sorbents as replacements for those currently used.
- Ground testing of alternative carbon dioxide removal and compression systems.
- Ground testing various solid/liquid/thermal ammonia derivatives as an alternative to current systems.

Life Support Systems Sustaining Humans Beyond Earth

➢ Trace Contaminant and Particulate Control

In collaboration with the National Research Council's Committee on Toxicology, NASA has established guidelines for safe and acceptable levels of individual contaminants in spacecraft air and drinking water. A spacecraft cabin trace contaminant and particulate control system keeps the environment below the spacecraft's maximum allowable concentration for chemicals and particulates. Particulates are small particles of matter like dust and aerosols.

Both passive (filters) and active (scrubbers) methods contribute to the overall trace contaminant and particulate control system design. Work to advance technology and capability in this area under is focused on making improvements to current space station systems to improve performance and reduce consumables. Specific tasks include:

- Developing new technologies to control trace contamination.
- Testing technologies to monitor aerosols in spacecraft.
- Developing filtration technologies for particulate control to meet exploration requirements and reduce crew maintenance requirements.

Life Support Systems Sustaining Humans Beyond Earth

➢ WATER MANAGEMENT

A major goal of life support systems is the development of water recovery systems to support long duration human exploration in deep space. Wastewater management systems have been designed to recycle crew-member urine, wastewater, and humidity for reuse as clean water. By doing so, the system reduces the amount of water and consumables that would need to be launched from Earth

Current ISS systems recover water at a rate of approximately 74 percent. For longer, further missions into deep space, this rate must be increased so that astronauts can journey for months without resupply missions from Earth.

To achieve this, the LSS work is underway to:

- Develop technologies to achieve 98 percent water loop closure.
- Increase reliability and robustness over current technologies.
- Reduce mass, power and volume as compared to current technologies.

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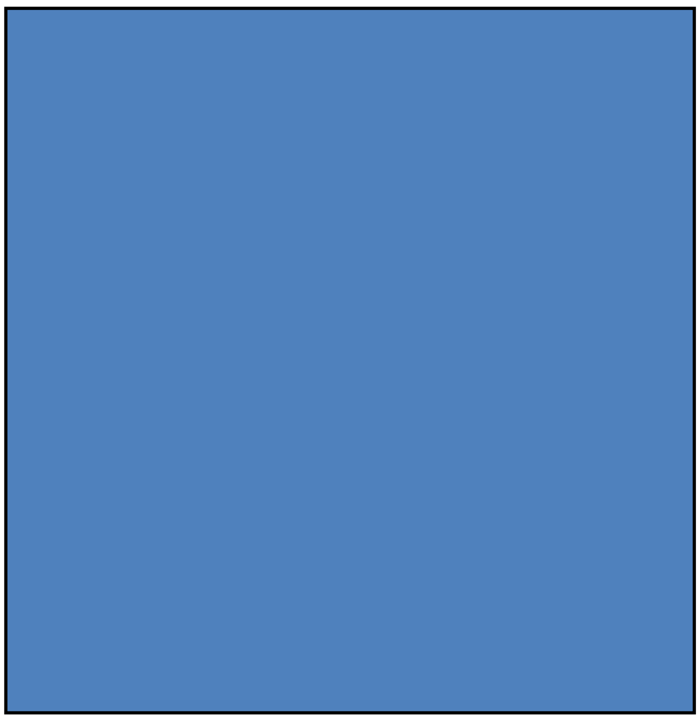

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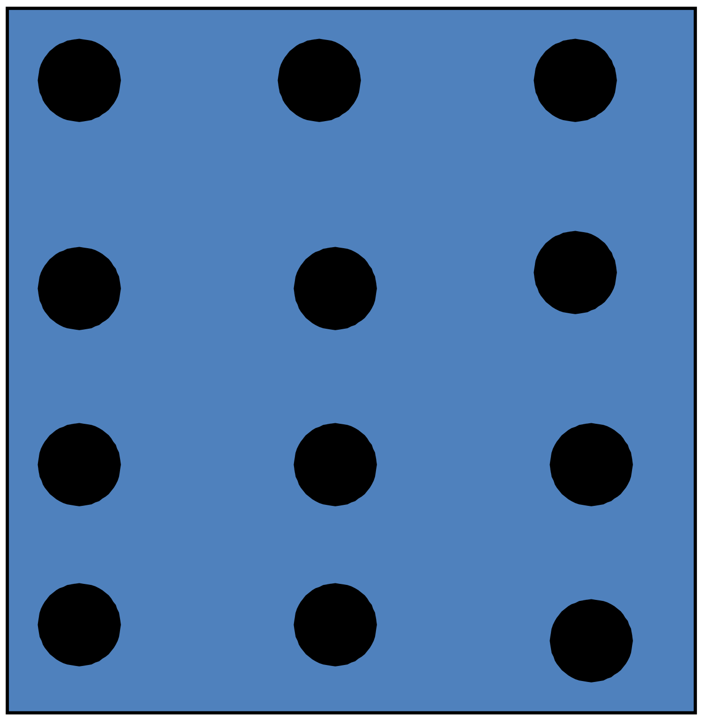

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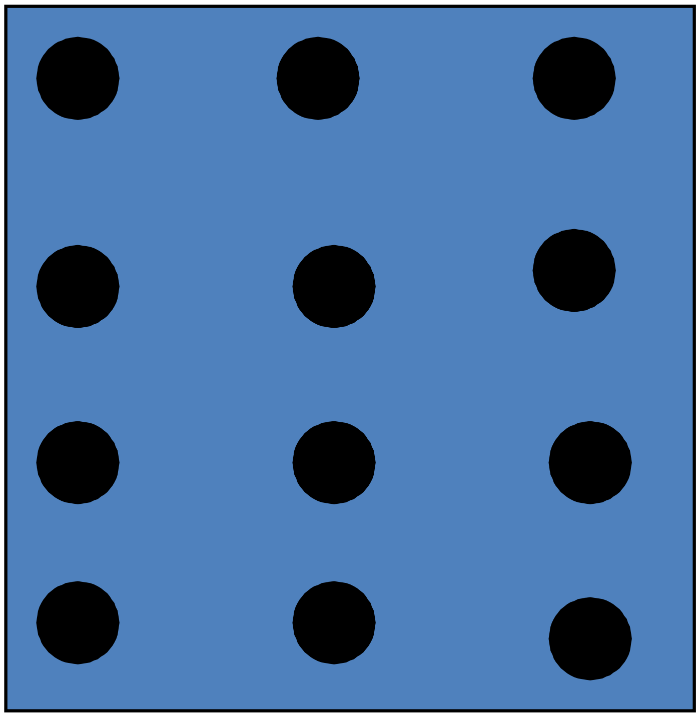

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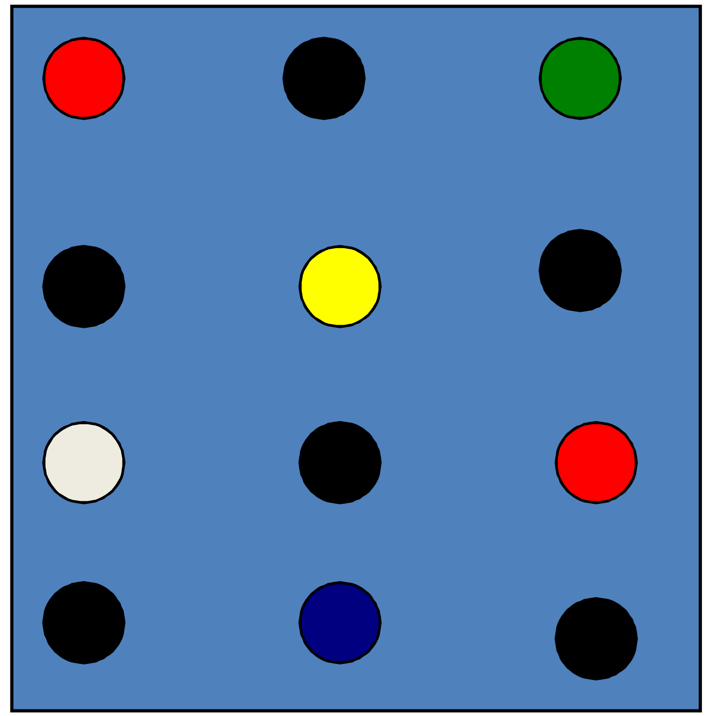

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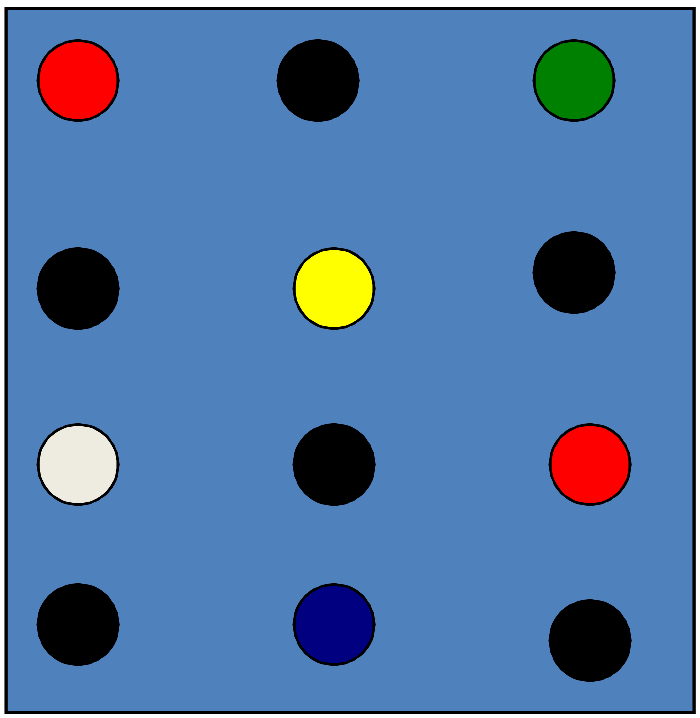

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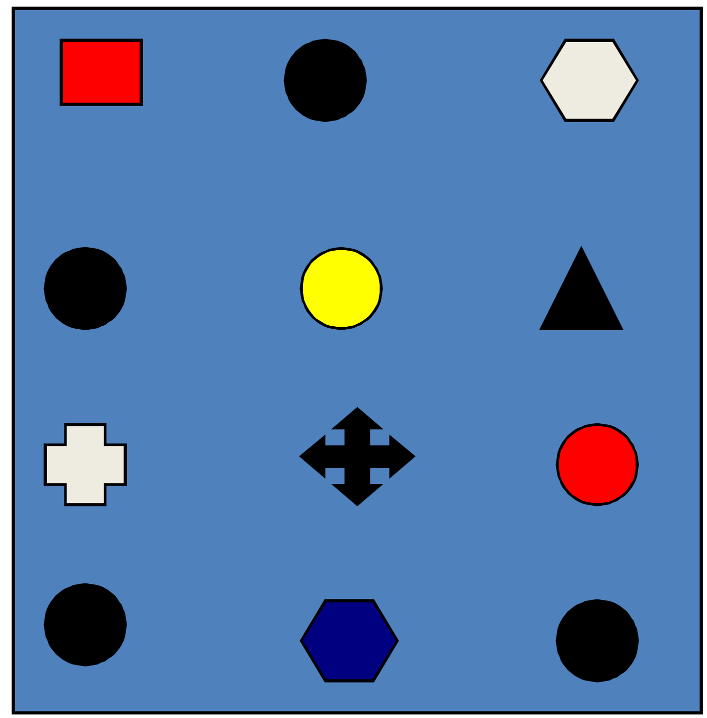

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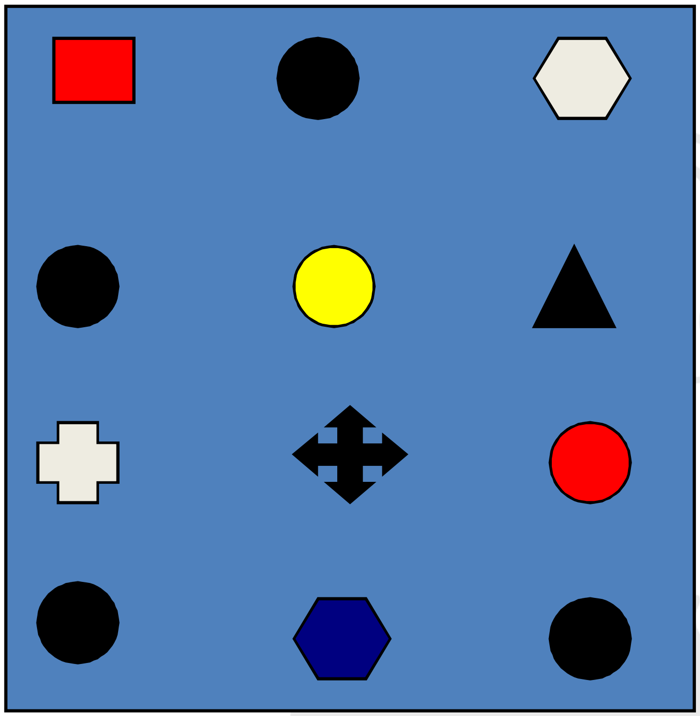

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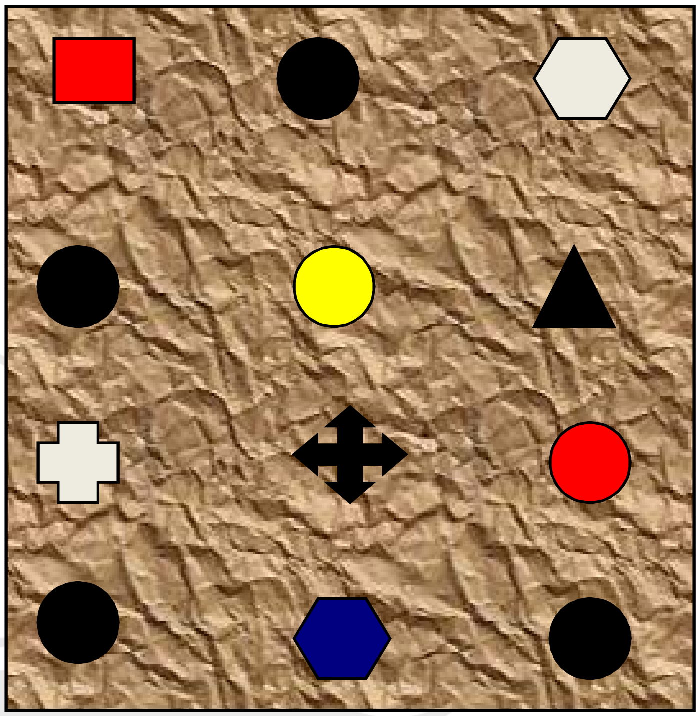

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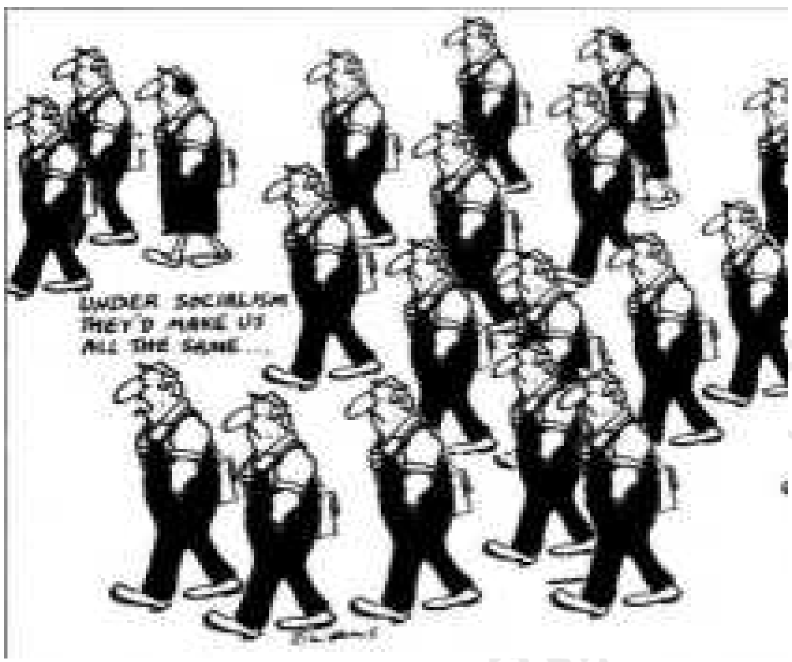

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Which do you like better?

A **B**

Which do you like better?

A

B

Biodiversity

What does "Bio" mean?

Bio = Life

Biodiversity

What does "Diversity" mean?

Diversity = Variety

Biodiversity is the **variety of life** on Earth and the **essential interdependence of all living things**

- **Scientists have identified more than 1.4 million species. Tens of millions -- remain unknown (www.thecatalogueoflife.org)**

- **The tremendous variety of life on Earth is made possible by complex interactions among all living things including micro-oganisms.**

There are 3 components of biodiversity

1. **<u>Diversity of genes</u>**
   Chihuahuas, beagles, and rottweilers are all the same species —but they're not the same because there is variety in their genes.

Chihuahua

Beagle

Rottweilers

There are 3 components of biodiversity

2. Diversity of number of species

For example, monkeys, dragonflies, and meadow beauties are all different species.

Saki Monkey

Golden Skimmer

Meadow Beauty

There are 3 components of biodiversity

3. Variety of ecosystems

Lakes, Ponds, and Rivers are all Freshwater Ecosystems.

Rocky coast, Sand Dune, Estuary, Salt Marsh , Coral Reef are all Marine Ecosystems.

So what's an ECOSYSTEM???

ECOSYSTEM DEFINITION

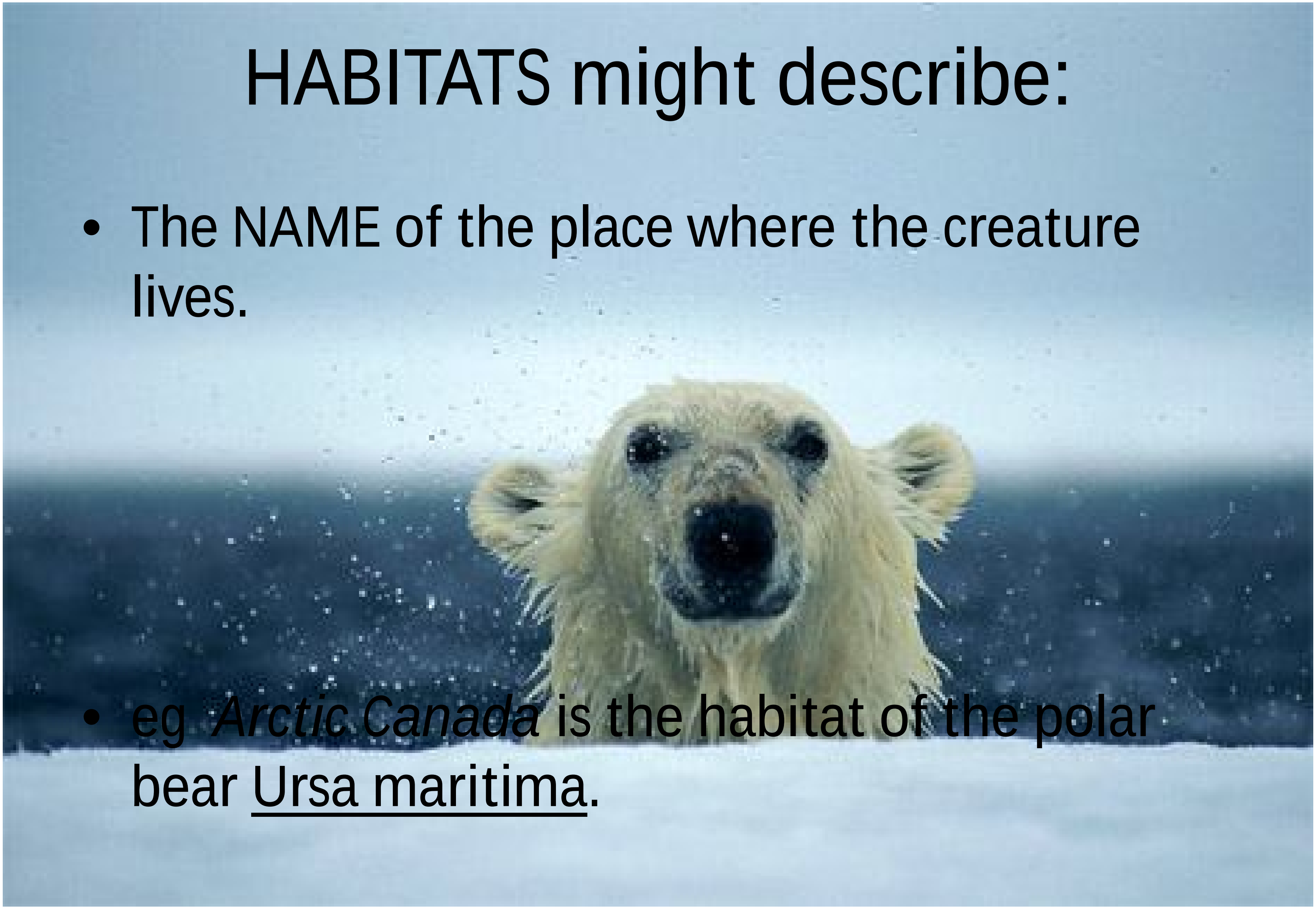
“ A self-contained community of microorganisms, animals and plants, that interact with each other and with their physical environment.”

eg a rock pool

Within an ecosystem there can be many HABITATS

- This is the **physical and chemical** description of where a creature lives...

HABITATS might describe:

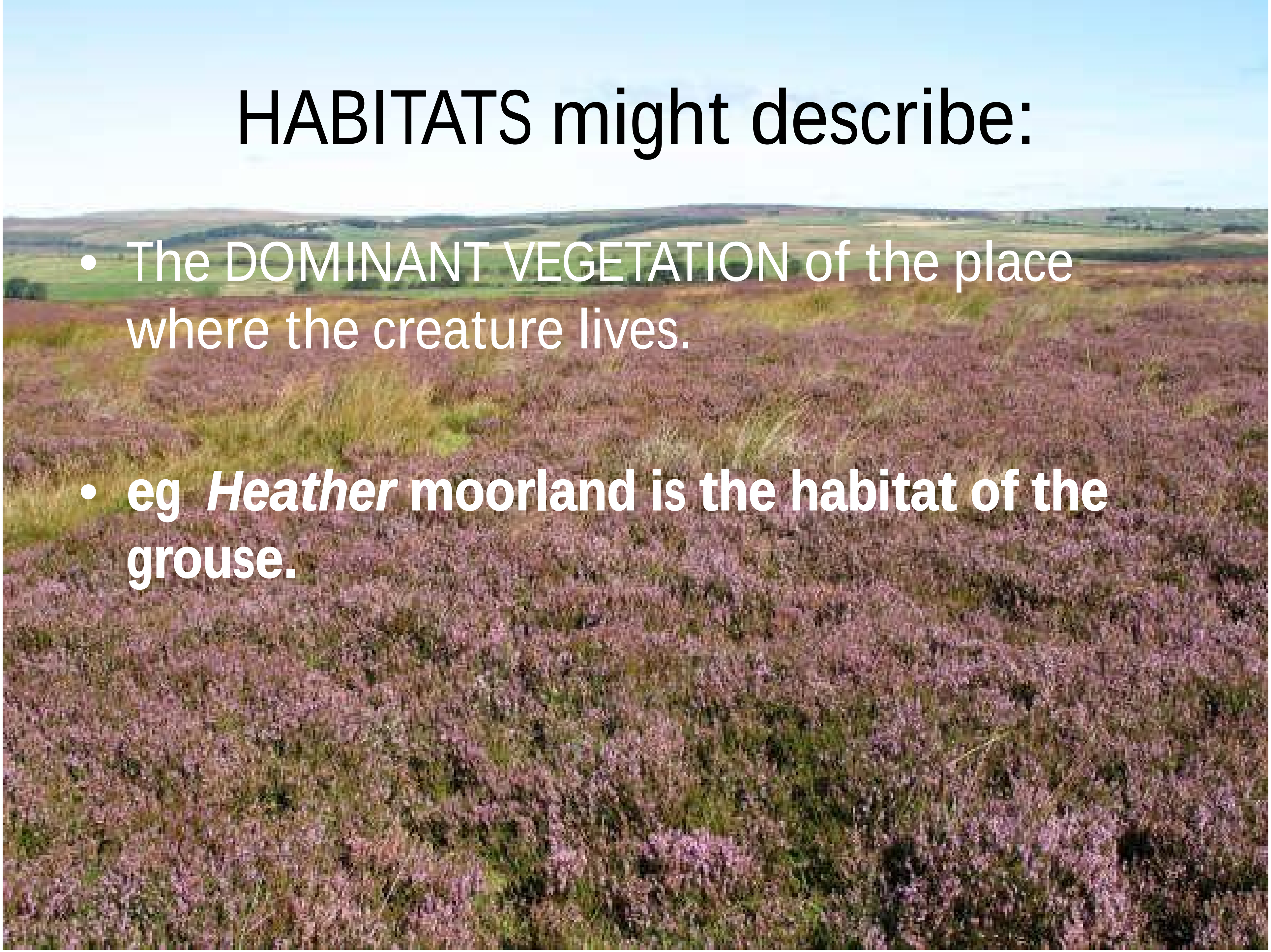


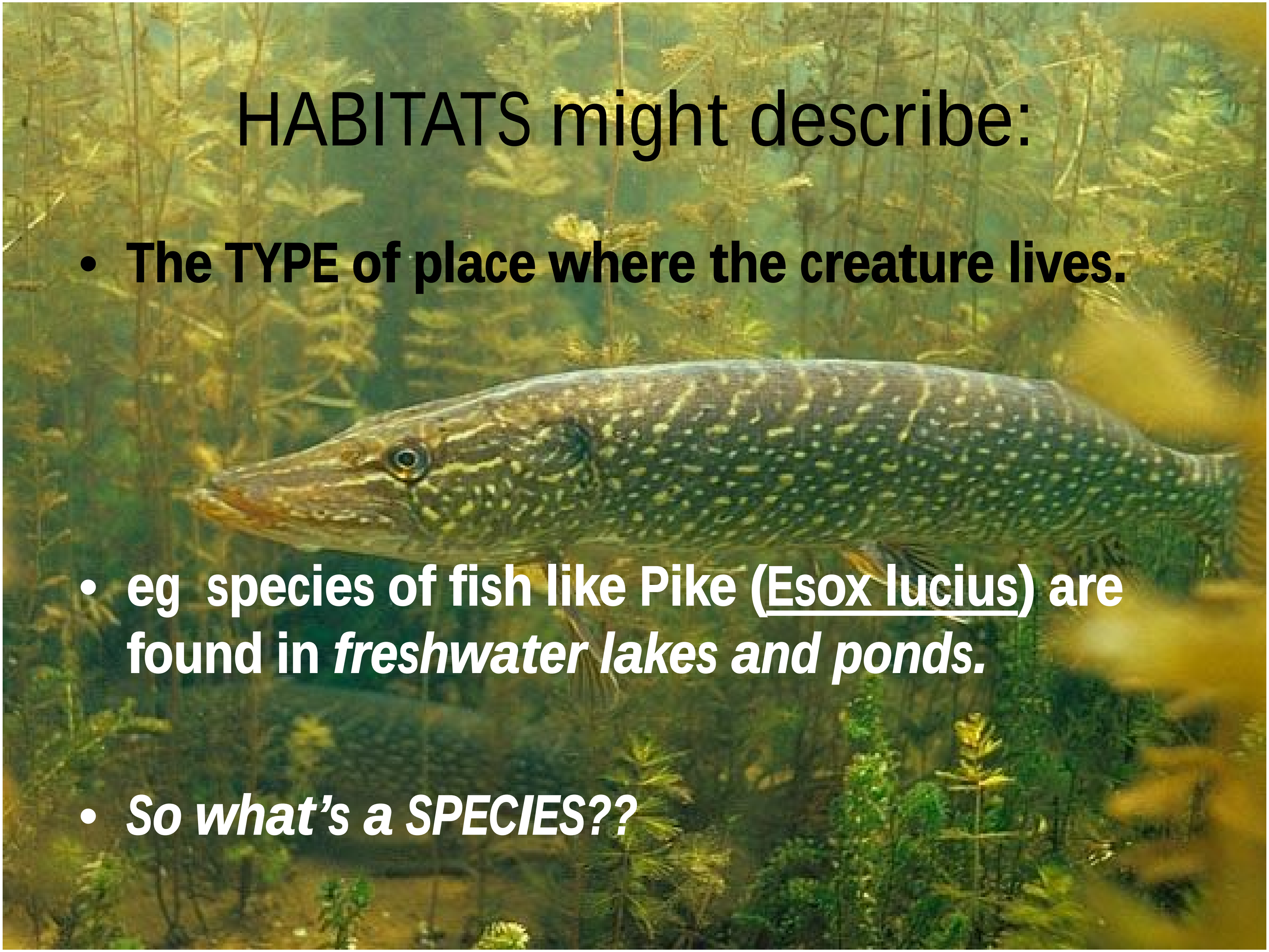
- The NAME of the place where the creature lives.
- eg *Arctic Canada* is the habitat of the polar bear <u>Ursa maritima</u>.

HABITATS might describe:

- The DOMINANT VEGETATION of the place where the creature lives.

- **eg *Heather* moorland is the habitat of the grouse.**





HABITATS might describe:

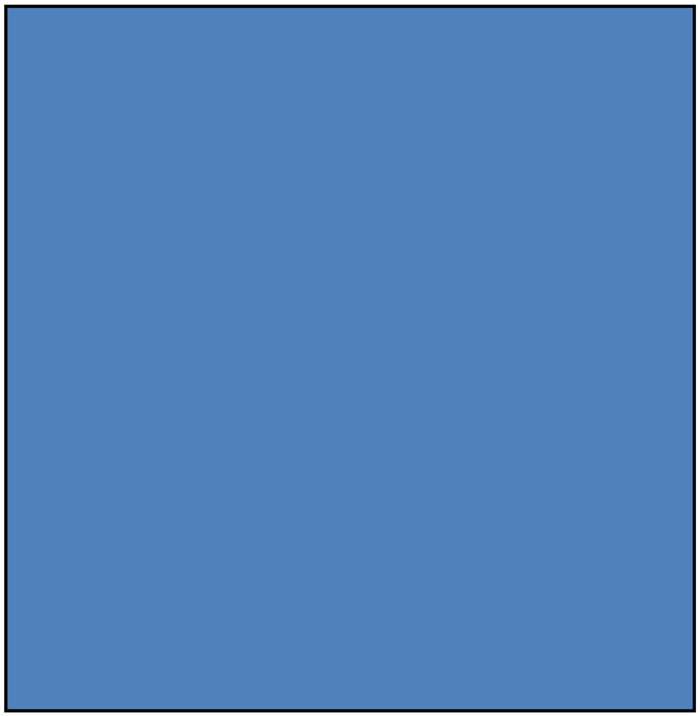
- **The TYPE of place where the creature lives.**

- **eg species of fish like Pike (Esox lucius) are found in *freshwater lakes and ponds.***

- ***So what's a SPECIES??***

A species is difficult to define exactly!!

Which is more diverse?



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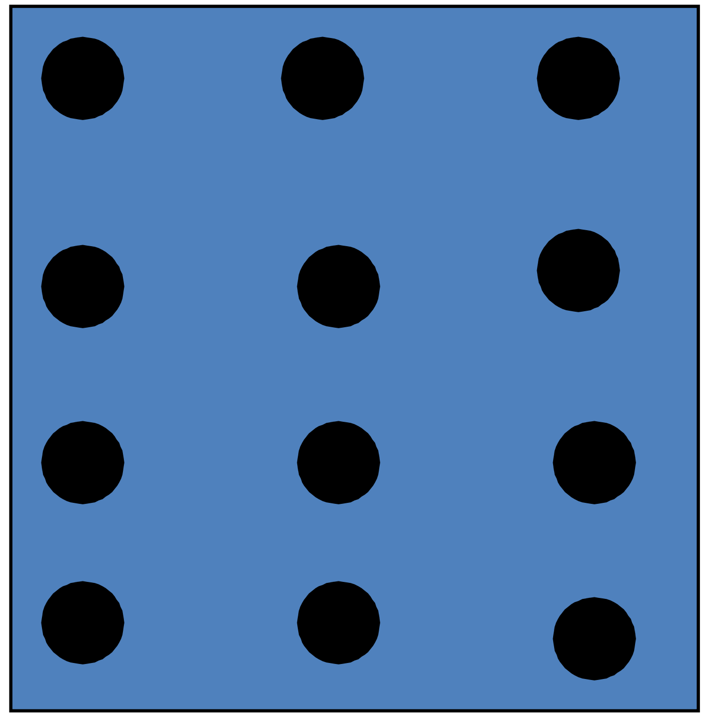

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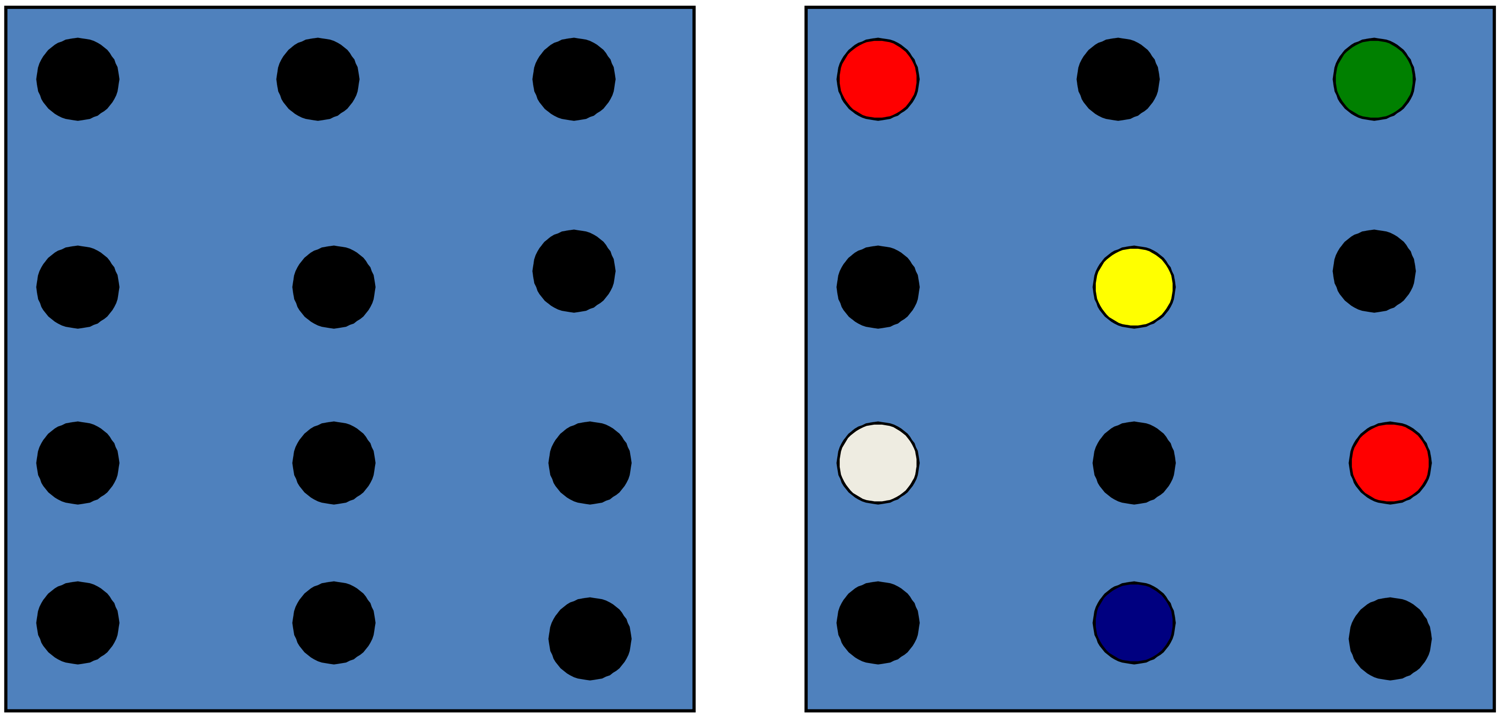
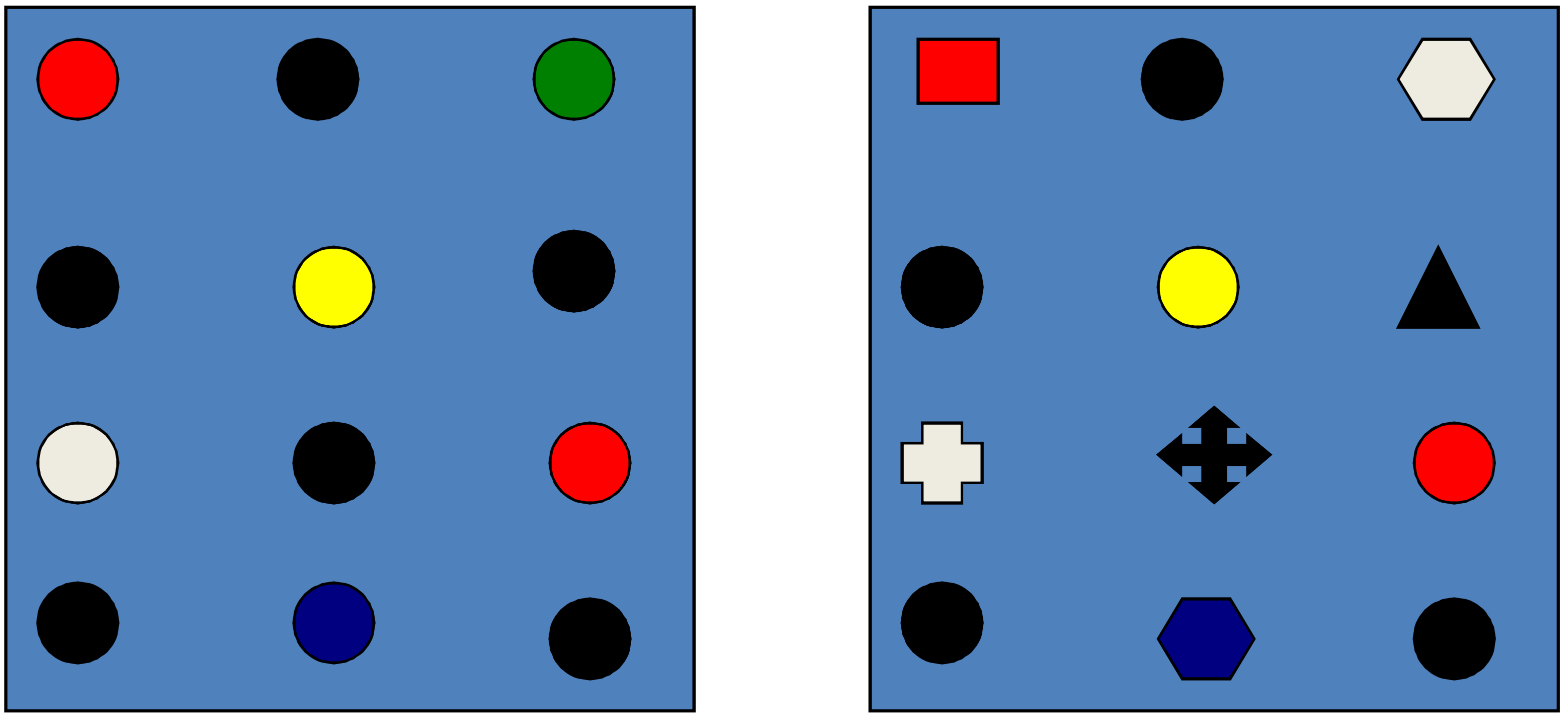
Which is more diverse?



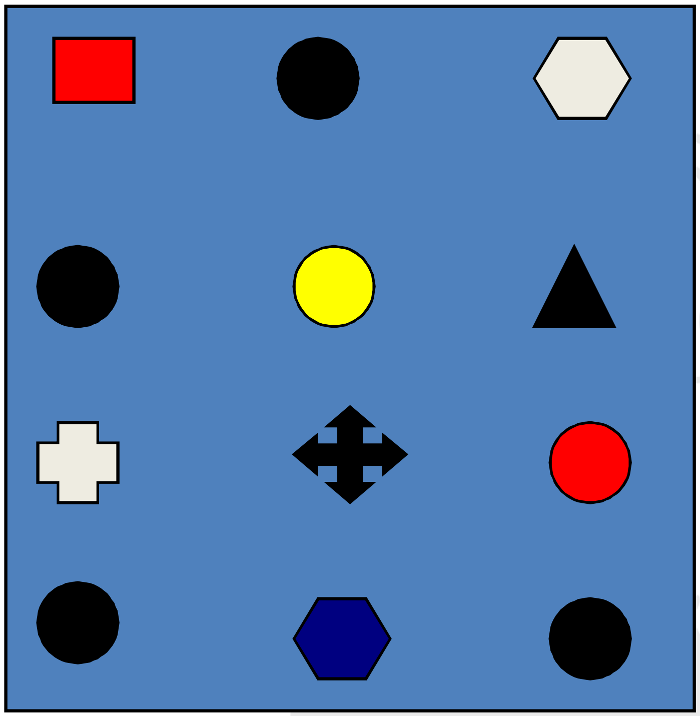
A B

Which is more diverse?



A B

Which is more diverse?



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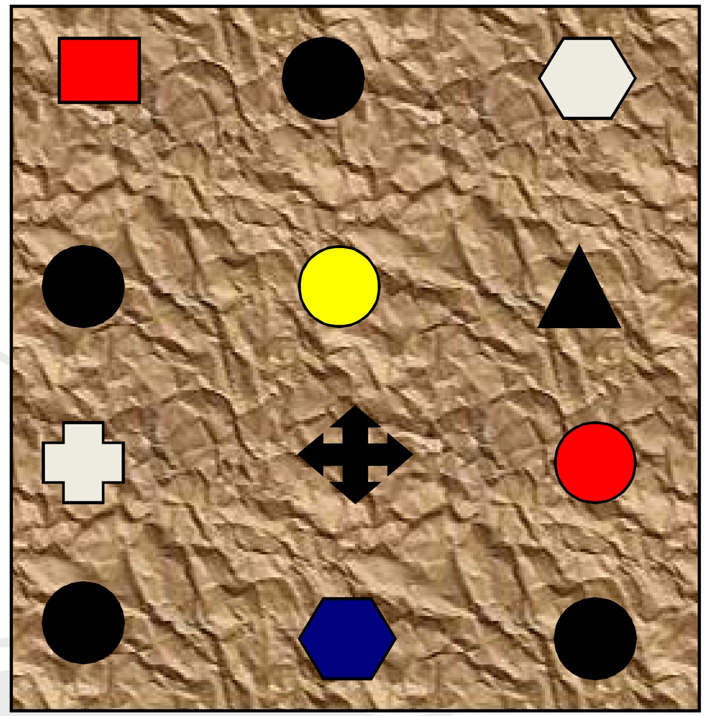

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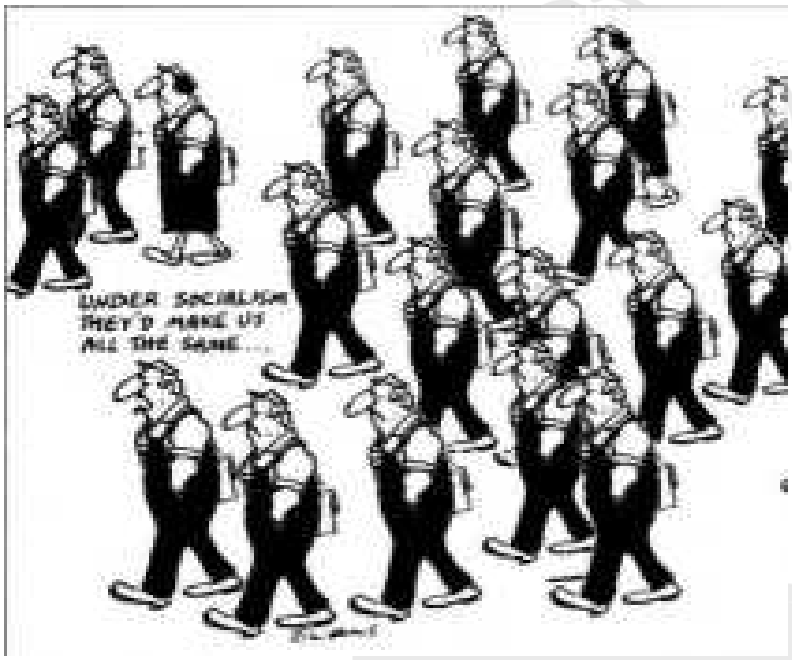
Which has more cultural diversity?



A

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Which has more biodiversity?

A

B

Which has more biodiversity?

A **B**

What do we get from biodiversity?

Oxygen

Food

Clean Water

Medicine

Aesthetics

Ideas

Should we be concerned about biodiversity?

What we know:

<u>The Earth is losing species at an alarming rate</u>

- Some scientists estimate that as many as 3 species per hour are going extinct and 20,000 extinctions occur each year.
- when species of plants and animals go extinct, many other species are affected.

Threats to biodiversity

Habitat destruction

Pollution

Species Introductions

Global Climate Change

Exploitation

Why is biodiversity important for sustainable development?

Biodiversity is important for sustainable development in many ways, as it provides the critical foundation for sustainable development and human well-being:

(i) At the simplest level, the components of biodiversity comprise many natural resources essential for human development including food, fibre, fuel, and medicinal plants. These are provided both from managed agricultural ecosystems and less managed "natural" ecosystems.

(ii) Biodiversity also underpins the functioning of these ecosystems and the provision of ecosystem services such as clean water (quality, quantity and evenness of supply), as well as services such as pollination, regulation of pests and diseases, etc.

(iii) Ecosystems, species and genetic diversity provide for adaptation to current needs and adaptability to meet future needs. Ecosystem resilience depends on biodiversity.

(iv) Biodiversity also provides spiritual, psychological and cultural benefits.

Why is biodiversity important for sustainable development?

The goods and services provided by biodiversity are important to all people. Some are especially important to poor and vulnerable groups as they are often most directly dependent on biodiversity and ecosystems and thus are often most immediately affected by their loss and degradation. Therefore, the goods and services provided by biodiversity constitute social safety nets. Women and men may utilize ecosystem goods and services in different ways. Some of the benefits from biodiversity are realized in the short term, others over longer periods, including over periods spanning multiple human generations.

Ultimately, the loss of biodiversity impacts negatively on all people. However, the loss of biodiversity may have particularly severe, and sometimes more immediate, impacts on the poor and vulnerable and on women and children. As biodiversity is lost, there is a risk that some thresholds will be passed, undermining the functioning of the earth system. Conversely, the conservation and sustainable use of biodiversity contributes to sustainable development and mitigation and adaptation to climate change. The SDG framework is an opportunity to reinstate that biodiversity contributes to human well- being, but also that biodiversity – as an essential element of earth's life support system – needs protection to ensure sustainability.

Why is sustainable development important for biodiversity?

A true sustainable development framework must not only acknowledge the role of biodiversity for development, it must also provide the enabling conditions for its conservation and sustainable use. To do this, the post 2015 framework needs to promote transformational change in economies and societies. This will require improved governance and institutions at multiple scales as well as behavioural change, and building human capabilities through access to education and health care.

Economic growth contributes to poverty eradication, but must be pursued in a socially equitable way, with a reduced impact on biodiversity and ecosystems, if it is to address the multiple dimensions of human well-being in a sustainable manner. Growth will be essential in developing countries to eradicate poverty, and for the foreseeable future, it will be necessary in all countries to ensure full employment. Growth must therefore be decoupled from resource consumption and from negative impacts on biodiversity. Carbon neutral (or even carbon-negative) growth will be an important part of this. It may also be necessary to look beyond growth-based prosperity, especially in high-income countries.

Why is sustainable development important for biodiversity?

Transformation to sustainable production and consumption patterns implies a more even sharing of resources among a greater number of people: greater equality. Waste of food, and excessive levels of consumption of all resources, will need to be reduced. More equal societies tend to have higher levels of well-being across all sectors of society. Equality may therefore be considered as well as a means to development as well as an end in itself.

Increased investment in governance and institutions at multiple scales as well as education and health care, especially for women, will be essential to underpin the transformational changes necessary to achieve sustainable development. Improved institutions at appropriate scales (from local to global) will be essential to allow effective stewardship of natural resources including biodiversity, and to achieve the transformational changes referred to above. Public access to information about the state of biodiversity and ecosystems can contribute to better policies and better management. Institutions will be needed for the management of risks and the negotiation of trade-offs among stakeholder groups. Institutions need to be developed while recognizing the different roles of women and men in the management of natural resources. Empowerment of women (including through literacy and employment) is also a proven way to lower fertility rates and thereby reduce the rate of population growth.

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Biodiversity Is Important

- Between 1981 and 2006, 47% of cancer drugs and 34 per cent of all `small molecule new chemical entities´ (NCE) for all disease categories were natural products or derived directly from them.

- in Asia and Africa 80 per cent of the population relies on traditional medicine (including herbal medicine) for primary health care

- But no one has estimated the overall value of the loss of biodiversity as such and even the concept of biodiversity is problematic.

- Most work has focussed on valuing the services provided by natural ecosystems (MEA)

Ecosystems and Biodiversity

- Ecosystem services are derived from the complex biophysical systems. The MEA defines ecosystem services under four headings: provisioning, regulating, cultural and supporting.

- Ecosystem functioning depends on its biodiversity. More diverse ecosystems are more stable and less subject to malfunction.

- We need a measure of system capability that includes its biodiversity.

TYPE OF ECOSYSTEM SERVICE	
Provisioning Services	**Regulating services**
Food and fibre	Air quality maintenance
Fuel	Climate regulation (eg temperature and precipitation, carbon storage)
Biochemicals, natural medicines, and pharmaceuticals	Water regulation (eg flood prevention, timing and magnitude of runoff, aquifer recharge)
Ornamental resources	Erosion control
Fresh water	Water purification and waste management
Cultural services	Regulation of human diseases
Cultural diversity, spiritual and religious values, educational values, inspiration, aesthetic values, social relations, sense of place and identity	Biological control (e.g. loss of natural predator of pests)
Cultural heritage values	Pollination
Recreation and ecotourism	Storm protection (damage by hurricanes or large waves)
Supporting services	Fire resistance (change of vegetation cover lead increased fire susceptibility)
Primary production	Avalanche protection
Nutrient cycling	Other (loss of indicator species)
Soil formation	

Biodiversity and Ecosystem Habitats are Declining

- Species are estimated to be going extinct at rates 100 to 1000 times faster than in geological times.
- The planet has lost 50 per cent of its wetlands, 40 per cent of its forests and 35 per cent of its mangroves.
- Around 60 per cent of global ecosystem services have been degraded in just 50 years

These Losses Matter in Economic and Welfare Terms

- The services that ecosystems provide are of value, especially to poor people. Thus if they are lost the impacts are all the more a matter of concern.
- In this paper we look at changes in the services from major ecosystems in South Asia over the last century and see where there have been major changes.
- We then value the services India currently derives from its ecosystems and examine their composition and distribution.

The Methodology

- The method adopted is to measure the size of an ecosystem taking account of its biodiversity. This is measured by an estimate of the Mean Species Abundance (MSA) of that system.

- The MSA is used to adjust the area of an ecosystem, so that if the MSA is 50% of the potential abundance the area is adjusted downward by an amount that reflects the lower productivity of a system with 50% lower MSA.