A2 Geography 4.3 Ecosystems Student Notes

- **An The management opportunities and challenges associated with Temperate Grassland Ecosystems.**

For the synoptic link, you need to be aware of the variables influencing the ability of people to overcome the challenges of these ecosystems in order to exploit opportunities. These variables include capital, technology and knowledge.

You need to be aware of the **issues of environmental concern** and the **sustainable management possibilities**.

There are clear links in this section with your studies of agriculture and development processes.

The locations of the main temperate grasslands are in the Prairies, the Pampas, the Veldt, the Steppes and in other, smaller pockets such as the Canterbury plain of New Zealand and the Downs of southeast Australia.

Temperate grassland occur in both **cool temperate** and **warm temperate** climatic zones. In cool temperate regions, grassland replace forests when the mean annual rainfall falls to about 500mm and in warm temperate regions when rainfall falls below 750mm.

NPP averages about 600 g/m^2/year compared with 2200 g/m^2/year in tropical rain forests and 1300 g/m^2/year in temperate forests.

Most precipitation (75%) falls in the summer months, coinciding with the highest evapotranspiration rates. Winter temperatures are usually substantially sub-zero, particularly in continental interiors.

Soils are usually a **chernozem type**, characterised by net upward movement of water and a deep, humus rich top soil (H-horizon) resulting from decaying grass blades and roots.

The grassland vegetation consists of species such as grama, buffalo grass (50cm), feather grass and tussock (or tufted) grass (2m).

Trees are prevented from growing by the tightly knit “sod” that the grasses form, and by the grazing pressures of herbivores such as gophers, rabbits, bison (buffalo), antelope and kangaroo (Australia).

The main carnivores include wolves, coyote and predatory birds such as eagles and hawks.

Grass roots extend down up to 2m to the water table. This helps to bind the soil and reduce soil erosion. The grasses die back to ground level in autumn to forma turf mat in which seeds lie dormant until the snowmelt, spring rains and higher spring temperatures stimulate germination. This leads to rapid growth in the summer.

Drought is a common problem and may be accompanied by fire, which also helps to prevent tree growth. The largest store of nutrients is the soil and includes the rhizomes and roots of the grasses.

The Prairie Grasslands of North America

The prairie grasslands of North America range from Texas in the southern United States to Saskatchewan in Canada, and from Illinois in the east to Wyoming in the west. Within this area are regional differences with the grasses growing taller in the east:

Climate - Rainfall decreases from east (1000mm+) to west (250mm), which is reflected in the grassland plant communities. The summer temperatures are warm (19^o in north to 28^{o}C in south), although evapotranspiration rates are also higher. Winter temperatures are cold (-15^o to -20^{o}C)

Soil - The western short grass prairies grow in chestnut or chernozem soils. In the wetter east, the tall grass prairies result in a prairies soil, which is part way between the chernozem and a brown earth. **Energy Flow** - low temperatures and lack of sunlight limit the net primary production of prairie grass in the winter and by high levels of summer evapotranspiration during the summer. Most of the energy is stored in the biomass below the ground surface.

Nutrient Cycling – In the short grass prairies, most nutrients are stored in the soil. Humus is added to the soil each year by decaying grass. Most nutrient cycling takes place below ground.

Threats to Prairie Biodiversity in North Dakota

Before human exploitation of the prairie grasslands of North Dakota, there was a wide range of breeding grounds for migratory birds and a wide range of environmental niches related to climate, relief and soil, which supported a wealth of biodiversity. The prairies in this area were particularly vulnerable as habitats were irregular in shape and easily fragmented by human activity.

Approximately 98% of the habitats of the three main species of prairie dog have been eliminated by disease, agricultural activity and urban development since the 1900's. Other areas, which are major breeding grounds for migratory birds have been destroyed or fragmented by agriculture.

Native plants have been damaged by the influx of alien species such as the flowering leafy spurge. This is invasive and it attracts away pollinating insects, which have a potentially damaging effect on the native species, which rely on the same pollinators.

Pockets of original prairie grassland remain, but in small fragmented areas which are often below the minimum critical size for all but the smallest of species.

The 1930's Dust Bowl

In the 1930's, the prairie lands of SE Colorado, SW Kansas and parts of Oklahoma and New Mexico, Texas and New Mexico were turned to what became known as the dust bowl. The cause was a combination of an unpredictable climate, which culminated in a **severe drought**, Human causes included **overgrazing** and attempts to plough and **cultivate former grassland areas**.

The protective grassland mat and its network of water retaining roots were damaged or removed. The nutrient depleted topsoil lost structure and became powdery. The soil was then blown away in the spring winds. The soil drifted and at times blocked out the sun. Some dust was blown as far as the east coast of the USA.

The consequence was not just environmental destruction, but economic ruin for many American farming families. Out migration took place from the region in the peak of the Great Depression of the 1930's. Government aid was made available to stop the wind erosion. Windbreaks were planted and areas or arable land were restored to grassland. A partial recovery had been made by the 1940's although soil erosion remains a problem in the area even today related to overgrazing and poor methods of cultivation.

Other Impacts of Human Activity in the Prairies

Modern Cereal Farming – Despite the Dust Bowl problems of the 1930's, and soil conservation methods that were introduced, droughts between 1950 and 1985 led to further soil damage in areas under cereal cultivation. An estimated 1m of soil has been lost from some fields (as much as 25 tonnes per hectare).

Damming Major Rivers, Irrigation and Flood Control - Many hectares of prairie grassland, and related riparian ecosystems, have disappeared under the water behind dams and under flood control schemes and under **i**rrigation schemes for intensive arable farms.

Hunting and Trapping – Native American's have always hunted and animals but it was only when European hunters came that there was a major impact on the ecosystem. In the 17th Century there was an estimated 60 million bison grazing in he prairies. By 1890, there were barely 1000. Fur trappers also reduced the populations further by using bison and elk for winter food.

Mineral Extraction - Open cast coal mining and oil exploration, together with pipeline, road and rail links, have had their impact on prairie grassland with little environmental consideration.

The Impact of Cattle Ranching on Biodiversity

"John Wayne, Hamburgers and Cookouts"

Cattle ranching and beef production, with their roots in the "wild west frontier" are an important part of the US economy in the prairies as well as a part of the national cultural heritage. On the face of it, ranching seems well in tune with the natural rhythms of the prairie grassland ecosystem. The turf remains unploughed and the cattle, grazing in low densities, merely replace the wild animals such as bison, bighorn sheep, elk and antelope.

However there are now concerns about the **carrying capacity** of the grasslands and the impact of cattle ranching as stocking levels have gradually risen. Much of the grazed land is central government (federal) land, which is leased to farmers, so the government have the ultimate control on stocking levels.

A debate has risen as to whether low density grazing is economically sustainable or whether higher density grazing is environmentally sustainable. This is set against a broader debate about the relative inefficiency of red meat production as a means of feeding larger numbers of people although there is a high demand for high-protein beef in the US economy.

The Concerns About Cattle Ranching

About 44% of the land area of the USA is devoted to cattle ranching but NPP is only 60% of the natural state. Reduced plant cover leads to less leaf litter, higher evaporation and lower interception rates. This leads to faster runoff with a greater **risk of flood**.

Loss of ground cover also accelerates **soil erosion**. The eroded soil changes silts up rivers and causes eutrophication, disturbing the ecological balance of the rivers.

Of particular concern is the **riparian zone**, the narrow strip of water dependent vegetation that line riverbanks. Cattle accumulate in this zone and trample vegetation. The riparian zone is only 1% of the total habitat but it contains 75% of its vertebrate species. In Arizona, less than 3% of the riparian zone remains.

Cattle drink more than native bison, they do not roam as widely and they do not eat the dry vegetation. Many depend on irrigated fodder crops such as alfalfa and maize. This has created a high **demand for water** leading to the damming and drainage of rivers with dire consequences for river ecology. Aquifers are also seriously depleted.

At least half of the available **forage** on the prairies is eaten by cattle. These compete with native species ranging from grasshoppers to bison. Numbers of some species remain at critical levels.

The Case for Cattle Ranching

The poor image of cattle rearing can be attributed to feedlot rearing whereby animals are fed on hay and grain. Under such methods 2.25 litres of fuel, 4.8 kg pf grain and 3000 litres of water are consumed to produce 1kg of beef. Grass fed ranging cattle require much lower levels of inputs.

Grazing is essential to reduce the risk of wildfire hazards during the dry season as tinder is removed. Grazing also prevents the dominance of tall species, therefore helping to retain biodiversity.
Most of the damage caused by cattle ranching can be attributed to mismanagement. Stock rearing methods were imported from more humid climates. Cattle can be reared in a more sustainable way. Wild buffalo roamed in herds for protection from predators. Urine and dung were concentrated and the animals kept moving to avoid feeding on fouled ground. Grazed and trodden areas were therefore both enriched and had time to recover.

Cattle, without predators, spread out and do not roam, so areas become overgrazed. The answer is to change the management strategies to imitate the behaviour of the native bison. Large concentrated herds can be brought to an area, perhaps by using an attraction such as salt or hay. Once he land has

been grazed and manured, the same methods can be used to draw the cattle to another part of he range. Such methods can be part of an organic farming system.

Is sustainable management possible in the Prairies?

Conservationists believe that cattle ranching has already damaged the natural balance of prairie grasslands but a proposal to develop a 130,000ha National park in Kansas has come across strong opposition from local farmers.

A further 1,500,000ha has been placed under the management of the Forest Service as " 18 National Grasslands" Management requires reconciling the interests of grazers, recreational interests water supply, timber and wildlife. Progress has been made in rehabilitating over grazed areas although the amount of fencing has increased.

On the Pawnee National Grassland in NE Colorado, cattle numbers are deliberately reduced in winter so to maintain the protective vegetation cover, therefore reducing surface runoff and flood risk. Camping grounds, picnic sites, bird watching hides have also been introduced as part of a conservation and environmental protection scheme.

What do you think is the potential impact of the US beef consumers in the future management of the prairie grassland ecosystem?

Chalk Grassland

Plagioclimax grassland communities

In year 12 you studied the **plagioclimax** at Braunton Burrows in North Devon on a dune pasture. Plagioclimax occur when people manage the ecosystem in such a way that it is prevented from moving to the next **seral** stage (usually scrubland).

The chalk grassland ecosystem is partly a **plagioclimax** formed by sheep grazing and partly a **biotic** climax caused by the actions of rabbits. Such grazing prevents the reestablishment of shrub or tree species, sine the animals eat their young shoots and seeds. The grazing also prevents competitive grasses from dominating and allows a diverse turf of flowers, herbs and grasses to thrive. The rich flora provides a suitable habitat for a wide range of insects, especially butterflies, birds and small mammals. Chalk grassland usually forms over a thin, calcareous **rendzina** soil, which is thin and prevents the growth of any **calcifuges** (plants that cannot thrive in alkaline conditions).

Chalk grassland was once common on the Chilterns, North and South Downs, Salisbury Plain, and the Lincolnshire and Yorkshire Wolds

Why is Chalk Grassland Under Threat?

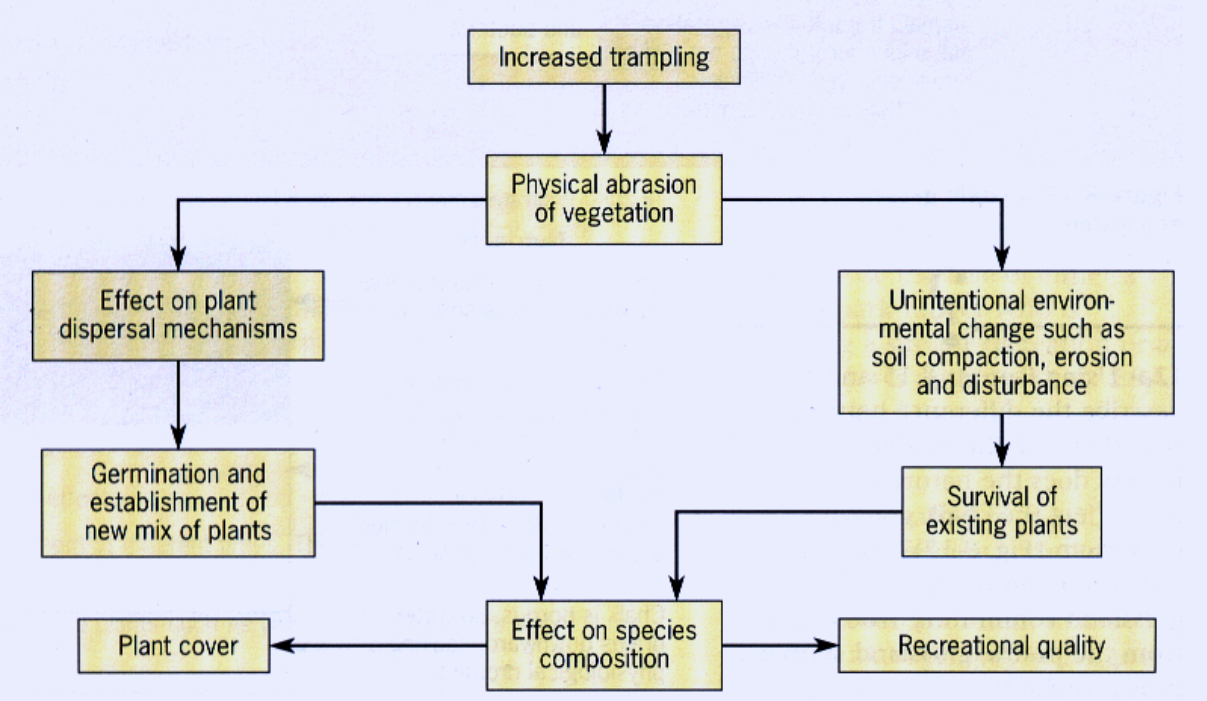
The history of chalk grassland can be traced back to about 3000BC when early farmers cleared woodland for crops. The soils became impoverished so by 1300, sheep and rabbit grazing dominated. At times, arable farming encroached onto the downlands but sheep grazing remained important until 1945. In the post war period, farmers received government grants to convert grassland to arable land and to improve pasture for sheep grazing by adding fertilisers. This helped grasses to grow but reduced biodiversity. The amount of chalk grassland rapidly declined.

By 1950, areas not ploughed were abandoned and grazed by rabbits. However the introduction of myxomatosis in 1953 devastated the rabbit population allowing shrubs to establish themselves and take over the remaining downland.

By the 1970's, there was a significant decline in butterfly and bird species, along with flora. The large blue butterfly became extinct.

By the mid 1980's, less intensive farming had allowed limited recovery of some areas of downland.

In recreational areas, trampling can cause localised damage to the ecosystem leading to a reduction in biodiversity



Managing Chalk Grassland

A few pockets of chalk grassland remain, such as in the Braddenham and West Wycombe Hill areas and at Ivinghoe Beacon. Careful management can help to improve biodiversity. This can include:

- Using selective herbicides on invasive thistles and docks.
- Cutting the vegetation in May and September to prevent shrub growth. Cuttings must be removed to avoid any mulching effect
- Low intensity sheep grazing to control aggressive grasses and to allow flowers to produce seed. Sheep prefer grass, but stocking densities need to be low.
- Graze with cattle for short periods to clear dead plant litter.
- Graze different parts of each site at different times to encourage a wide diversity of flowers.
- Weed out invasive species such as thistles, hawthorn and brambles.

Chalk grassland management can be part of sustainable organic livestock management.

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