RANGELAND IMPROVEMENTS

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Summary

The increase of the grazing value of natural vegetation may be achieved in various ways using interventions either singly or in combination. Natural vegetation includes both plant species that are palatable to livestock and game and preferred by them, but also other species that are ignored by large herbivores. The second group of plants increases in importance as the intensity of the grazing pressure mounts. The proportions of both entities in a given site is an indication an of the grazing value of the vegetation under consideration. Improvement of grazing lands is thus the increasing of the first entity at the expense of the second, opposite to the usual overgrazing practice.

Under usual circumstances, the grazed species undergo a selective disadvantage with regard to the non-grazed species, due to the damage they suffer from the grazing action. Improvement may just involve restoring the balance between these two entities by, for example, adjusting the stocking rate to the carrying capacity, i.e. the number of animal this vegetation may sustain on the long run.

Other improvement actions may be under-stocking, total protection (exclosure), deferred grazing, reseeding of high quality and productive species, introduction of soil conservation practices that increase water intake and soil productivity, additions of organic or chemical fertilization. These kinds of actions however should not be introduced indiscriminately, the selection of one or the other depend on a number of parameters linked to the climate, to the nature of the soil, to the management ability of the graziers and to the cost effectiveness of the technique selected under the particular circumstances. For decades it has been estimated that the toll levied by grazers should not include more than 50 % of the biomass of the good grazing species present. But recent research suggested that this proportion should not exceed 30%, particularly in arid lands. The correct evaluation of any improvement of range grazing and evolution requires some sort of monitoring over time. Here again the number of options is large depending on the resources available in manpower, time and money.

1. General Introduction and Definitions

Rangelands are areas of natural vegetation primarily utilized for the grazing of livestock and/or game (See *Range and Animal Sciences and Resources Management*). These vegetations may be very diverse and bioclimatically distinct: timberland, protection forest, woodland, bushland, shrubland of various kinds, prairie, savanna, steppe and desert. The improvement methods utilized are just as diverse; they may be fully natural or highly artificial depending on the weight of the human action and investment involved in the improvement process. Rangelands occupy about 51 % of the land mass of the planet, i.e.6.7 x 10^9 km ^{2}. When discarding the 45 million km^2 of icy deserts (High mountains, Antarctica, Alaska, N. Canada, Greenland, Iceland, N. Siberia, N Scandinavia) and the 9.5 Mn km^2 of hot desert wasteland (Sahara, Near and Middle Asian, Takla-Makan, Chilean-Peruvian, Namibian), this proportion drops to ca. 43 % of the land mass. World rangelands harbor some 200 million cattle equivalents (TLU), i.e. about 20 % of the world livestock population. The annual economic output is evaluated at about one billion US. This surface area represents a human population of nearly one billion people. Ca. 478 million ha of rangelands are located in the USA (51 % of the land area of the state), west of the 100° W meridian. where they harbor for 70 million cattle, 8 million sheep, 40 million white tailed deer, 10 million mule deer, 55,000 wild horses and burros, 0.5 million pronghorn antelopes, 0.4 million elks.

Natural improvements may involve a relatively light human impact such as the manipulation of stocking rates, fire management, temporary protection from grazing (exclosure) while artificial improvements include heavier human impact or investment such as fencing, soil and water protection and conservation techniques, runoff and water control, soil and water conservation techniques, pitting, fertilizing, reseeding, revegetation, legislative action measures, and all the techniques of range rehabilitation.

Improvement is concerned with the increase of the grazing value of any piece of rangeland. The grazing value is measured through the output of the range in terms of animal production, or by the measured increase of grazing primary production in qualitative and quantitative terms, which amounts to the same but is easier to evaluate. Any improvement, however, is based on an assessment of the past and present situations of the range; i.e. a relatively accurate evaluation of the resource and its evolution with

time. That means the availability of a base line study and its subsequent monitoring. The resulting data may exhibit various degrees of accuracy and of cost-benefit ratios.

Items	Hyper-arid	Arid	Semi-arid	Total
AI(1)	<6	6-30	30-50	--
SM km^2(2)	14.6	14.6	13.0	42.2
S% (3)	11.0	11.0	10.0	32.0
DrSn (4)	365	245-365	160-245	--

(1) Aridity Index : 100 P / ETo.
(2) Areas in Million km^2.
(3) Percent of the world land mass.
(4) Length of the annual dry season, days (P < 0.35 ETo or P < 2 T in days), T being the mean monthly temperature in °C.

Table 1. Aridity Zoning of world rangelands

Continents	Highlands (1)	Temperate (2)	Mediterranean & Subtropical (3)	Tropical (4)	Equatorial (5)	Total	%
N America	--	460	75	390	--	1,025	7.0
S. America	120	430	55	359	120	1,084	7.5
Africa	--	--	730	2172	898	3,800	26.0
Asia	800	2,300	1,715	600	--	3138	37.0
Australia			1,100	2,200		33	22.5
Total	920	3,190	3,675	5,721	1,018	14,632	--
Percent	6.2	21.9	25.1	39.8	7.0	--	100

(1) Particularly Tibet and Andean Puna.
(2) Mean annual temperature between 5 and 15 °C.
(3) Winter season rains, summer drought.

Table 2. Bioclimatic and continental distribution of rangelands in 10^3 km^2, and percent.

2. Rangeland Types

As suggested above, rangelands are very diverse from the bioclimatic view-point they may develop under humid, sub-humid, semi-arid, arid and hyper-arid climates with an annual rain to potential evapotranspiration rate (Aridity Index) varying from above 100 % to below 5 %. They thus may occur under a variety of climatic zones: Temperate, Mediterranean, Tropical, Equatorial all having cold (highlands and continental) to warm winters (lowlands and littoral).

From their structural viewpoint they may qualify as forest, woodlands, bushlands (trees and shrubs), shrublands, prairie, meadow, savanna, steppe, desert waste, they may be based on perennial species or on annual species, or both (see *Rangeland Plants(Grasses, forbs, shrubs and trees):role and function*).

Particularly important is the perennial-grasses component of the rangelands, as they provide an important part of the diet of the stock and game. But other components may be locally very important too, such as the fodder shrubs, which, in addition, are an

important source of protein and the basic feed for some species of stock (goats and camels) and game such as cervidae, Black Rhino, Eland, Giraffe, etc.

3. A Case Study of the US Rangelands.

US rangelands play a particular role in the world for a variety of reasons. Their study represents more that 80 % of the range science literature for the past 80 years. A number of US universities have acquired a world leadership in this discipline and a majority of scientists and leaders in other countries were trained in these US Universities: Utah State, Logan; Colorado State, Ft Collins; Texas A & M, College Station; Berkeley, California, Oregon State, University of Wyoming, University of Arizona, Tucson, Arizona State University, Tempe, New Mexico State University, Las Cruces, University of Nevada, Reno, and others. In addition there are many research stations, state and federal, including the USDA Forest Service, Agricultural Research Service, Department of Fish and Game, Soil Conservation Service, Bureau of Land Management, etc. The US rangelands occupy the following areas, in 10^9 ha (Table 3).

	Total land area	Sown pastures	Perennial pastures	Open range	Forested range	Total Grazing Land	% Graz. Lds
North East	46.9	1.0	21.0	0.0	0.7	5.5	48
North Centre	202.1	9.9	18.2	32.8	58.0	65.9	59
South East	226.0	13.0	27.8	48.8	18.5	101.8	48
West	470.6	3.1	6.8	250.0	47.9	299.2	65
Total US	945.6	27.0	73.8	331.6	125.1	472.4	51
%	100	2.9	7.8	35.1	13.2	50.0	--

Table 3. Grazing lands in the US, by category and region (Units: million of hectares).

Species	Numbers in 10^6	Mean Population Weight (kg)*	Overall stocking 10^6 kg LWt	Area Stocking 10^6 kg LW t/ha	%
Bison	50	450	22.750	48	73
White Ted.deer	40	60	2.400	5	8
Pronghorn Ant	40	50	2.000	4	6
Elk	10	240	2.400	5	8
Mule deer	10	80	800	2	3
Black tailed deer	3	60	240	0.5	1.0
Big horn sheep	1.5	80	120	0.3	0.8
Mountain goat	1	65	65	0.1	0.2
Total	155.5		26.375	64.9	100.0

Table 4. Estimated game stocking rates in the US rangelands in the 19 the century (calculated and rounded from the published data)

It is to be noted in passing that the proportion of rangelands in the US is the same as in the world at large (51 %).

Species	Numbers in 10^6	Mean Population Weight (kg)*	Overall stocking 10^6 kg LWt	Area Stocking 10^6 kg LW t/ha	%
Cattle (1)	70	300	21,000	44	66.0
Sheep (1)	8	40	3,200	7	11.0
Goats (2)	0.5	30	18	0.4	0.6
White tailed deer (3)	22	60	1,320	2.8	5.3
Mule deer (3)	6	80	480	1.0	0.2
Elk (3)	1.0	240	240	0.5	1.0
Pronghorn antelope (3)	0.5	50	25	0.5	1.0
Big horn sheep	1.5	80	120	0.25	0.5
Total livestock	78.5		23,218	48.6	91.0
Total Big game (4)	31.4		2,185	5.0	9.0
Grand total	109,9		25,403	53.2	100.0

Notes on sources:

(1) Heady and Child, 1994 ; (2) FAO Production yearbooks,1992 ; (3) T.E. Fulbright, personal communication ; (4) Excluding the Alaska territory and feral brumbies and burros. Official estimations of big game numbers vary very largely ; for instance for white tailed deer the figures for the year 2006 vary from12.5 to 30 million individuals and 4.5 to 7 million for mule deer. I have retained the medium figures between the extremes.

Table 5. Estimated present numbers and stocking rates of livestock and big game in the US rangelands at the present time (calculated and rounded from published data[1]). (1)Heady and Child, 1994; (2) FAO Production yearbooks, 1992; (3) T. Fulbright, personal communication; (4) Excluding the Alaska territory and feral brumbies and burros. Official estimations of big game numbers vary very largely; for instance for white tailed deer the figures for the year 2006 vary from 12.5 to 30 vary very largely; for instance for white tailed deer the figures for the year 2006 vary from 12.5 to 30 million individuals and 4.5 to 7 million for mule deer. I have retained the medium figures between the extremes.

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A full list of 125 references to support these conclusions and/or provide the statistical base can be found on the author's website (www.geoclimatology.com). A short list of particularly significant and synthetic references is mentioned below, by alphabetical order of authors.

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Biographical Sketch

Dr. Le Houérou is one of the best rangeland ecologists in the world. He has a Doctoral degree from Montpellier University and holds several doctorates from other French Universities. He has worked in Arabia, Argentina, Chile, East Africa., North Africa, Southern Africa, the Near East, and in France, Italy, northern Mexico, the Sahel USA and West Asia. He is the author of some 450 scientific and technical papers including 40 books on arid land ecology flora. His career spans more than 40 years during which time he served as the chairman of the Continuing Committee for International Rangeland Congresses (1979-1988) - President of the IV International Rangeland Congress, Montpellier, 1991. He was a Research Scientist with the CNRS (National Scientific Research Council, Paris) in Montpellier from 1957 to 1992 and Professor of the French Universities (Applied Botany), Paris, in 1972. He has worked as free-lance International consultant on Arid Land Ecology since 1992 and continues to live and work in France. In 2008 he was named as one of 4 internationally-recognized scientists who shared in the IPCC Nobel Peace Prize that was awarded to the IPCC for work on global Climate change.