A Growth Form Method for Describing Browse Condition

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Browse utilization estimates can be based on relationships between twig diameter at the point it was browsed and initial twig weight (Basile and Hutchings 1966, Lyon 1970) on measurements of percent twigs browsed (Stickney 1966) or on the visual determination of form classes (Schmutz 1983). All of these methods express utilization along a scale ranging from 0 to 100% (0–90% in the case of Schmutz 1983). The ecologic implications of points on such a scale, however, vary among land managers.

A survey of browse condition may also be based on tree or shrub architecture. The concept is based on a discrete criterion: Does the level of grazing allow trees and shrubs to attain their normal stature? The concept arose from observations of Douglas fir, spruce, and willow growing on parts of the northern Yellowstone winter range within Yellowstone National Park. Trees less than about 10 years of age were often browsed or hedged to less than 1.3-ft tall. Nearby, trees (up to ca. 6.5-ft tall) had heavily-browsed stems that had been killed to within about 1.3-feet above the ground (Fig. 1, left center). Trees with this second growth form ranged from about 10–20 years of age. Older trees were highlined, but had live foliage above 6.5-ft (Fig. 1, right center).

The ages of these trees spanned a period in which Yellowstone's northern elk herd increased from less than 4,000 to more than 23,000 (Coughenour and Singer 1996). It seemed likely that the age-related growth forms were associated with an increase in grazing, and they formed the basis for the ideas described below.

The Method

This method recognizes 2 levels of browsing intensity: a) light-to-moderate, and b) intense. Under light-to-moderate browsing, young trees or shrubs may grow to the height typical of their kind. Browsing is defined as intense when it prevents young plants from attaining their normal stature. Four plant architectures are described that correspond with 4 different browsing regimes. The architectures are developed over the period of time that the terminal leaders are within reach of browsing animals.

Uninterrupted-growth-type architecture is produced under light-or-moder-

Fig. 1. *The upper stems of the Douglas firs at left center of the photograph have been killed by browsing, Surviving foliage is restricted to the base. The upper stems of somewhat older Douglas fir (right center) remain alive, however, the trees have been highlined. This age-related pattern indicates an increase in browsing intensity in the area.*

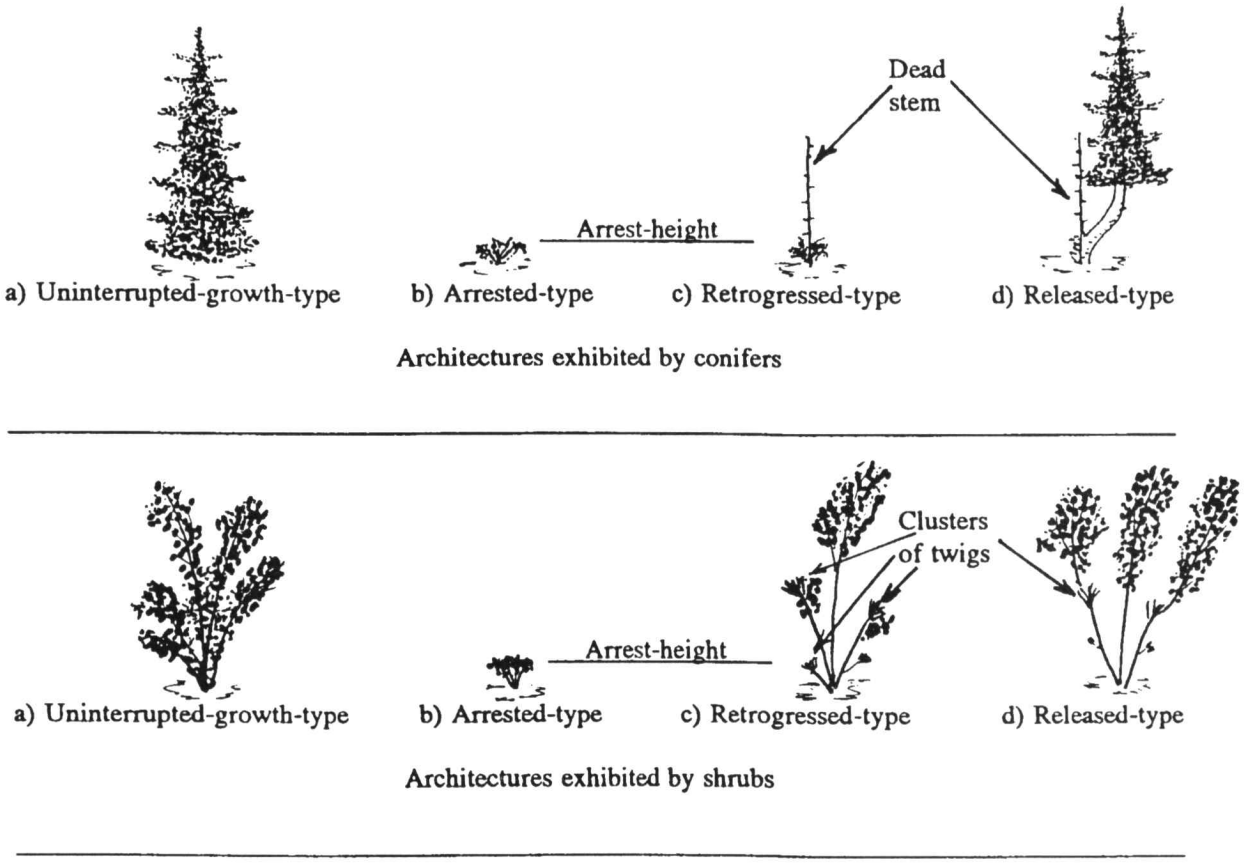

Fig. 2 *Architecture types that correspond to 4 browsing regimes: a) light-to-moderate browsing, b) intense browsing, c) a change from light-to-moderate to intense browsing, and d) a change from intense to light-to-moderate browsing for conifers and broad-leaf growth forms*

ate browsing (Fig. 2a). Young uninterrupted-growth-type individuals can attain typical tree or shrub height, however their rate of growth and shape may vary due to herbivory. The classification of a browse plant to uninterrupted-growth-type architecture is determined by a single criterion: As the terminal leader passes through the browse zone, it originates each year from last year's growth.

Arrested-type architecture is produced under intense browsing (Fig. 2b). Young plants often escape browsing until they grow tall enough to be noticed. For example, snowpack may provide temporary overwinter protection. Once tall enough to be discovered, these plants would be hedged at an "arrest" height. On the northern range, the arrest-height of willow can be as low as 4 inches. Arrested-type shrubs are composed of shoots of a uniform height that is determined by browsing. The classification of a given individual to arrested-type architecture is determined by 2 criteria:

1) Browsing caused the mortality of a terminal leader, and

2) The terminal leader of slightly shorter individuals would not have been killed. These plants will develop arrested-type architecture when they grow tall enough to project above snowpack.

Retrogressed-type architecture is produced when browsing changes from light-or-moderate to intense (Figs. 2c and 3). During the initial period of light-or-moderate herbivory, a young individual would grow taller than arrest-height. Once browsing becomes intense however, the upper stem (or stems) would be killed by girding or pruning. The classification of a given individual to retrogressed-type architecture is determined by 2 criteria:

1) Browsing caused the death of a terminal leader that had grown taller than arrest-height, and

2) Uninterrupted-growth-type individuals taller than the browse line (and resistant to girding) would be high-lined.

Retrogressed-type shrubs consist of shoots of diverse height, some of which are terminated by clusters of twigs (Fig. 4). The twig clusters record the position of shoot apices at the time browsing intensity increased.

Released-type architecture is produced when browsing changes from intense to light-to-moderate (Figs. 2d and 5). The lower (surviving) stems of arrested- or retrogressed-type trees would develop into trunks. In the case of shrubs, the resumption of shoot growth would leave dead clusters of twigs at an intermediate position along the shoot. There are 2 identification criteria:

1) The individual shows evidence of arrest or retrogession, and

2) As the individual's terminal leader passes through the browse zone after the period of arrest or retrogession, it

Fig. 3. *The terminal leader of this retrogressed-type aspen grew to 5-ft tall before the upper stem was killed by browsing. Live foliage was then restricted to a layer between ground level and 20 inches above ground level. Adjacent to this plant, the stems of young aspen are browsed to an 8 inch stubble.*

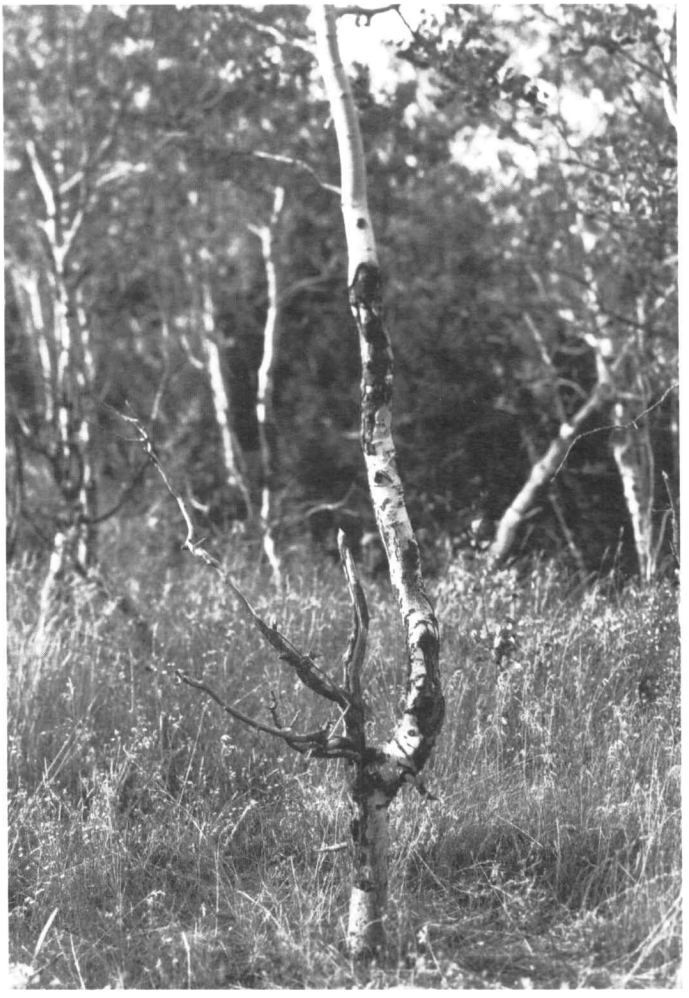

Fig. 4. *The original stem of this released-type aspen grew to 1.5-m tall before the upper segment died. The blunt truncations of twigs and partial girdling scars are evidence of herbivory and, possibly, antler rubbing by elk. A branch 24-inches above ground level survived to become a trunk 20-ft tall.*

originates each year from least year's growth.

Interpretation and Application

The validity of architecture-based interpretations of browsing intensity can be evaluated by determining, for a species, the extent to which: 1) all individuals within an age class reflect similar architectures, and 2) the extent to which different age classes reflect a similar history. For example, where browsing intensity has increased, one would expect the oldest individuals to exhibit uninterrupted-growth type architecture, middle-aged individuals to be retrogessed, and the youngest individuals to be of arrested-type architecture. A precise history may be determined through dendrochronologic techniques.

On a given site, the arrest or retrogression of the most highly preferred browse species marks the threshold detectable by this method. Higher browsing intensities could be differentiated by incorporating additional species that are less preferred by wildlife or livestock. For example, based on highly-preferred aspen and less-preferred Douglas fir, 3 browse-intensity categories logically occur: 1) both aspen and Douglas fir exhibit uninterrupted-growth-type architecture, 2) aspen exhibits arrested-type, while Douglas fir exhibits uninterrupted-growth type, and 3) both species exhibit arrested-type architecture. These categories could be used to define mapping units that, in turn, could be used to spatially describe utilization levels.

The percent twigs browsed and twig-weight: diameter methods (Basile and Hutchings 1966, Stickney 1966, Lyon 1970) are more precise than the method described above. But in some cases, an architecture-based survey may have important advantages. Compared to other methods, architecture-based surveys should be less time consuming, and so may enable land managers to assess the condition

Fig. 5. *Dense clusters of twigs terminate the shoots of this retrogressed-type Serviceberry at heights ranging from 20–50 inches above ground level. The growth form suggests that, under light-to-moderate herbivory, shoots grew to a range of heights that corresponded with shoot age. When herbivory changed to intense, clusters of twigs formed at the tips of the shoots. Some serviceberry shrubs nearby were uniformly browsed to a 20 inch stubble suggesting continuous intense herbivory.*

of larger areas than would be possible with other methods. The dendrochronologic analysis of architectures allows managers to compare present trends with conditions that existed in the past. This provides a historic perspective that adds a new dimension to browse surveys.

The simplicity of the plant architecture approach may simplify communication between diverse interest groups. Retrogressed-type architecture is compelling, easily-understood, evidence of an increase in herbivory. The architecture of young plants are indicative of future condition if use does not change. For example, under intense herbivory, there will be a shift to an arrested-type community as older, retrogressed- and uninterrupted-growth-type individuals die. Among people from diverse backgrounds, a common appreciation of browse condition may facilitate the resolution of politically sensitive cases.

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