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# Illustration of unproductive forests in Switzerland

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## 1 Context: Unproductive Forest in Switzerland's National Inventory Report

The definition of “unproductive forests” (CC13) used in Switzerland's National Inventory Report on Greenhouse gas Emissions (FOEN 2014) covers brush forests and forest on unproductive areas.

The national forest inventory does not incorporate these forests in its regular inventory scheme because 1) plots are difficult to access or it is not possible to carry out precise measurements (brush forests), (2) the plots are inaccessible or the NFI Forest definition is not fulfilled (forest on unproductive areas).

1. Brush forests: Since brush forests have no direct economical value in terms of wood harvest, the inventory of these stands has not been attributed high priority.
2. Forest on unproductive areas:
  - a) Inaccessible stands are forests which cannot be visited because of safety reasons (see description in Brändli 2010, p. 89).
  - b) Unproductive forests not covered by NFI: after the review of its Initial Report (FOEN 2006h), Switzerland had to apply a forest definition for reporting activities under KP Art. 3.3 and Art. 3.4, which is different from the definition applied by the Swiss NFI and the Land-Use Atatistic AREA. Because the country definition (NFI and AREA) was not in line with the specific requirements of the Kyoto forest definition, Switzerland had to develop an approach to classify certain AREA-categories as forest. Those areas are situated in the threshold range between forests and grassland with woody biomass of very low productivity, but are not covered by the regular NFI.

## **2 Documentation of Unproductive Forests**

### **2.1 Brush Forests**

#### **2.1.1 Changes in Living Biomass in Brush Forests**

In 71% of all brush forests in Switzerland, the dominant tree species is Green Alder (*Alnus viridis*). Alpine Pine (*Pinus mugo prostrate*) dominates in 20% of brush. There is little literature on Alpine pine available. In contrast, Green Alder has been described more often in literature since this tree species is colonizing abandoned alpine pastures at a spanking pace. Below, an overview of the studies reporting on growth of Green Alder is given.

Several authors could show that Green Alder has a strong annual gross growth, especially after germination (Michiels 1993) and can therefore easily dominate over closed brush cover (Mössmer and Ammer 1994, Körner and Hilscher 1978, Mürner 1999). Young trees of Green Alder have the highest rates of gross growth, which only decrease slightly with increasing age (Wettstein 1999). With  $6.18 \text{ t ha}^{-1} \text{ yr}^{-1}$ , Green Alder is one of the most productive species at high altitudes (Wiedmer and Senn-Irlet 2006). Even Norway Spruce (*Picea abies*) and Birch (*Betula pendula*) have lower rates of gross growth. Düggelin & Abegg (2011) found slightly lower values of gross growth for Green Alder in the Swiss Alps.

A precise determination of the age of Green Alder is generally difficult because roots can be much older than the branches, originating from sprouting from underground stems at or within 2 cm of the soil surface (Rubli 1976). Therefore, there is disagreement on the maximum age and the vitality of older stands of Green Alder. Rubli (1976) found that the average age of Green Alder stands is 50 years in the Swiss Alps and the maximum age amounts to 110 years. Körner and Hilscher (1978) described that 60 year old stands reach their maximum and are about to degenerate, whereas Hiltbrunner and Zehnder (2010) could show that stands with Green Alder in the Swiss Urserntal are still vital and do not collapse.

A literature review by Huber and Frehner (2012) shows that Green Alder has in general a strong annual gross growth, not only in very young stands, and that stands of Green Alder can be very vital at an age of over 100 years. The amount of carbon in living biomass lost due to mortality (there is no harvesting in these stands) cannot be higher than the maximum amount of carbon gain by gross growth. Thus, on the long term, carbon stored in living biomass of Green Alder is in equilibrium.

### 2.1.2 Illustration of stands of Brush Forests in the Swiss Alps



**Fig. 1:** Brush forest with Green Alder at Alp Vermii im Weisstannental (Canton of Sankt Gallen; photograph: Monika Frehner): As soon as an alpine meadow is abandoned, brushes and trees start to colonize the slope.



**Fig. 2:** The slope with Green Alder is situated in the Urserental (Canton of Uri; Photograph: Erika Hiltbrunner, University of Basel). In the Swiss Alps, brush forests with Green Alder are expanding and after a few years they cover the soil completely with their crowns.



**Fig. 3:** Slope with brush forest with Green Alder at Alp Valeis near Gaffia (Canton of Sargans; photograph: Monika Frehner): the meadow in the cauldron (brown color) is regularly cleared by hunters to stop colonization of Green Alder brushes.

## 2.2 Inaccessible Forest Stands on unproductive areas in the Swiss Alps

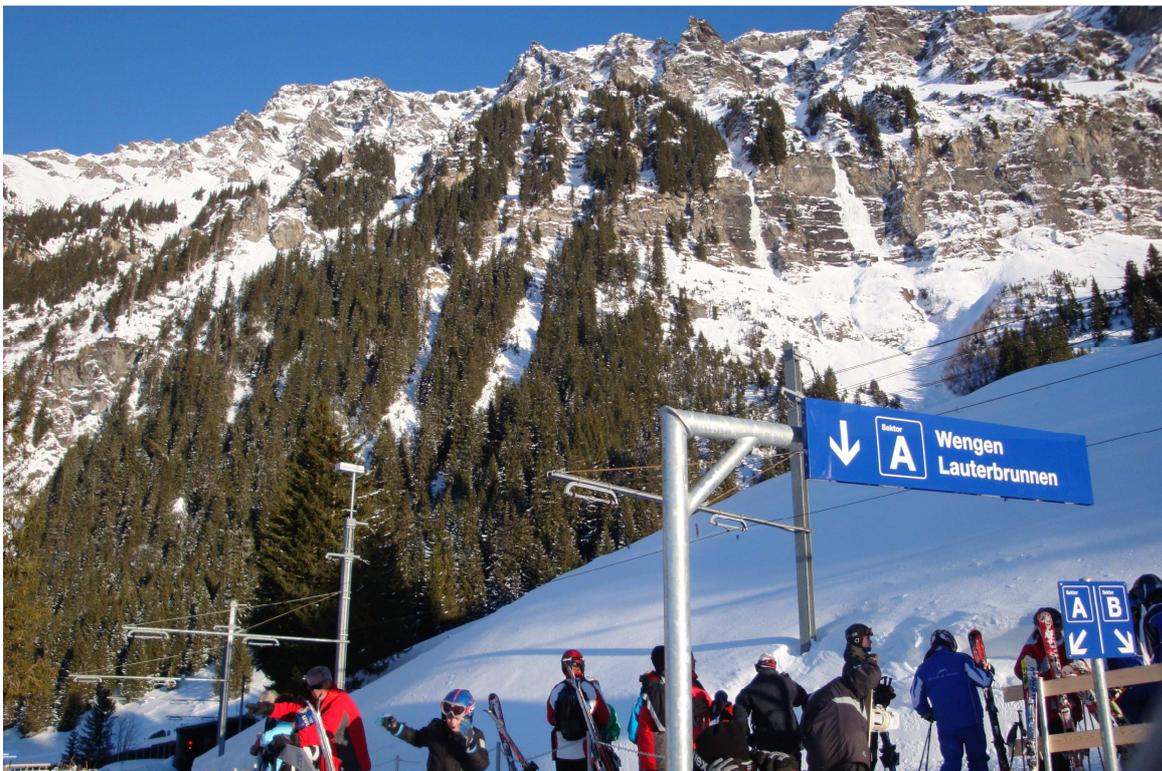
Inaccessible stands are forests which cannot be visited because of safety reasons. They are mainly located in the Alps and often grow on sites of low productivity: rocky sites, sites at high altitude near the tree line with a short vegetation period and low biological activity.



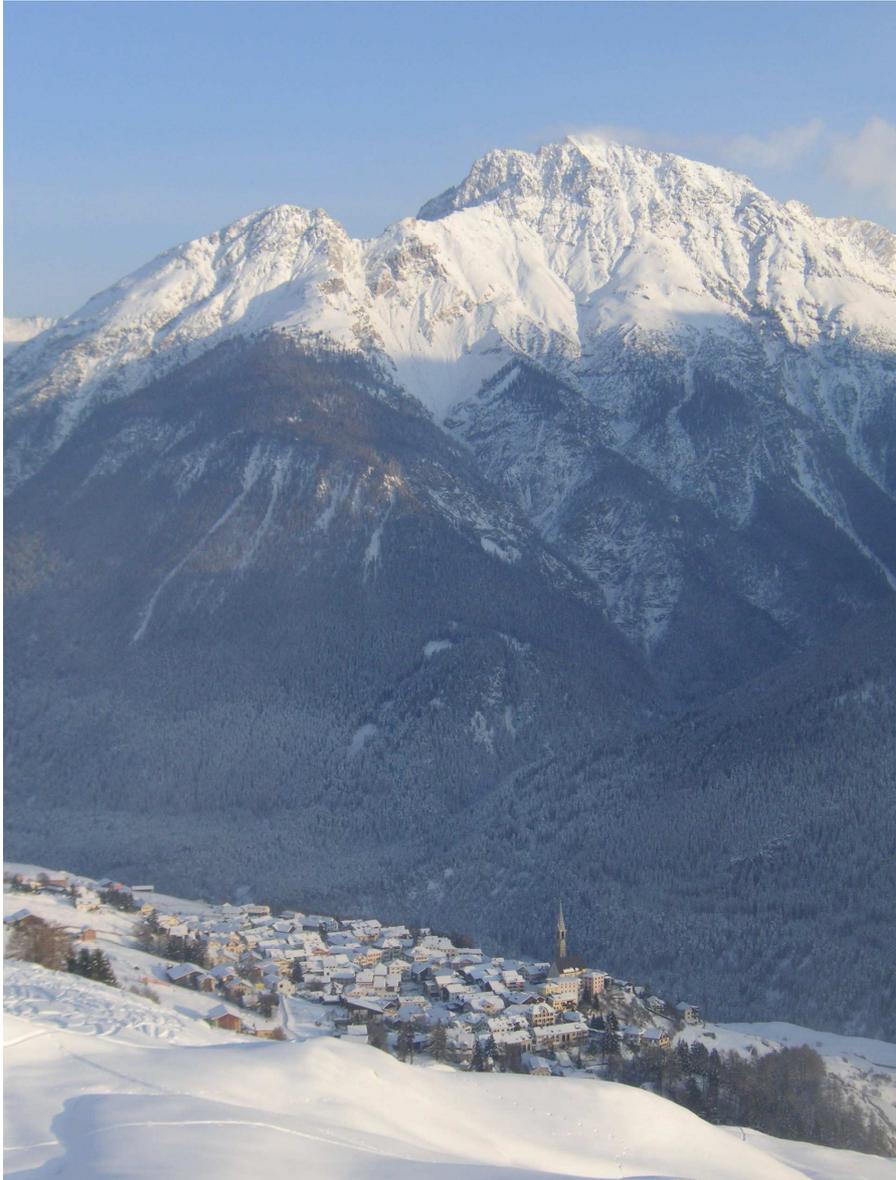
**Fig. 4:** Forested slope in Evolène (Canton of Valais; photograph: Christian KÜchli): vertical trails of cable cranes for logging are visible in the alpine forests. The forest above these logging trails is classified as unproductive forests, since it is not accessible for logging.



**Fig. 5:** A few trees are situated above the tree line in Gasterntal (Canton of Berne; photograph: Christian Küchli) growing in crevices at inaccessible places.



**Fig. 6:** Steep rocky slopes with scattered trees above Wengen (Canton of Berne; photograph: Christian Küchli). The lower forests are accessible and can be harvested with cable cranes. Stands above the rocky band are not accessible, and no harvesting takes place.



**Fig. 7:** Alpine Forest in Sent, Engadin (Canton of Grisons; photograph: Christian Küchli). Lower forests along the main valley of the Inn river are managed and can be logged with cable cranes. The higher-up stands (scattered appearance) are on rugged terrain, difficult to access and impossible to harvest.

### 2.3 References

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