ANTELOPE BRUSH HABITAT RESTORATION: DISTRICT LOT 953 (SIBCO)

PREPARED FOR:

Lora Nield, Senior Ecosystem Biologist,
Ministry of Forests, Lands and Natural Resource Operations
Resource Management, Ecosystems
102 Industrial Place
Penticton BC, V2A 7C8

ANTELOPE BRUSH, (*PURSHIA TRIDENTATA (PURSH) DC*), AN IMPORTANT SHRUB IN THE ANTELOPE BRUSH ECOSYSTEM.

PREPARED BY:

DAVID POLSTER, M.SC., R.P. BIO.
POLSTER ENVIRONMENTAL SERVICES LTD.
6015 MARY STREET
DUNCAN, BC, V9L 2G5

FEBRUARY, 2015

Report Citation: Polster, D. and G. Singleton. 2015. Antelope Brush Habitat Restoration: District Lot 953 (Sibco). Unpublished report prepared for the BC Ministry of Forests, Lands and Natural Resource Operations, Penticton, B.C. X pp.

Cover illustration: Antelope Brush, (*Purshia tridentata* (Pursh) DC). Report photos by David Polster.

Acknowledgements: Many people have contributed to this work; Jamie Leathem, Lora Nield, Orville Dyer and the organizers of the2003 Society for Ecological Restoration conference, “Ecosystems at Risk: Antelope Brush Restoration”.

Context of this report: This report has been prepared to provide the Ministry with a detailed restoration plan that could be taken to restore the Sibco property to support Behr’s Hairstreak butterflies. The report outlines the rationale behind the strategy so that an adaptive management approach can be used to refine the restoration work as it is conducted, making modifications as needed to ensure success.

1.0 INTRODUCTION

Natural ecosystem processes throughout British Columbia have been impacted by land management. This entailed controlling of fires, the introduction (intentional or not) of non-native species and the use of land for livestock grazing, all creating a stress on the natural ecosystems. Understanding how ecosystems respond to these stresses allows restoration treatments to be formulated that re-establish the historic balance. Ecological restoration is defined as the process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed (SERI 2004).

Fire, caused by lightening or humans, has been an integral part of the dry Interior ecosystems for thousands of years (Boyd 1999). Ponderosa Pine (*Pinus ponderosa* C. Lawson) forests are naturally maintained by fire (Photograph 1). The thick bark of the mature trees resist the frequent ground fires while the thinner bark of young trees often succumb, thus maintaining an open forest structure with an understory of grasses and forbs (Photograph 2). In the example shown in Photograph 1 younger trees persist in the rocky area where there is limited fuel for ground fires.

Photograph 1 (left) and 2 (right). The blackened trunk of the older ponderosa pine and the healthy clumps of native grasses, in this case bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) A. Love) (left) and the flowering forbs such as shaggy fleabane (*Erigeron pumilus* Cronq.) (right) create a diverse, resilient ecosystem that can support species at risk such as the Behr's Hairstreak butterfly.

Invasive species, notably knapweed (*Centaurea* spp.) (Photograph 3) and others (Photograph 4) can significantly derail recovery processes. Cheatgrass can change fire dynamics by providing a readily combustible fuel. Knapweed exudes a phytotoxic material that prevents establishment of seedlings in knapweed infested areas. Most invasive species usurp resources that would be used by native species without providing the ecological benefits of the native species. Although invasive species may be used by various native plants and animals for example Behr's hairstreak using baby's breath (*Gypsophila paniculata* L.), the long-term viability of having non-native species provide goods and services for native species does not account for the intricate web of species interactions that has evolved over eons in specific ecosystems. The concept of novel ecosystems (Hobbs et al. 2006) does not address this complexity. The novel ecosystem concept suggests that anthropogenic influences are so pervasive that we need to accept the changes that these influences have had on natural ecosystems (Hobbs et al. 2006). The fact that when ecosystem complexity and diversity is lost, resilience to future changes is reduced (Holling 1973) is one of the issues with allowing weedy species to take over natural ecosystems.

Management of invasive species is an essential part of ecological restoration. Building strong, resilient ecosystems can help prevent alien invasive species from establishing (Holling 1973; Polster 2003).

Photograph 3 (left) and 4 (right). Knapweed (left) and yellow salsify (*Tragopogon dubius* Scop.) (right) are invasive species that can have detrimental effects on natural ecosystems.

Habitat degradation occurs due to a variety of factors such as the control of fire that historically maintained the ecosystem in a specific state or occupation of the ecosystem by alien species such as Knapweeds or domestic cattle. In many cases, removing the degrading element is insufficient to ensure ecosystem recovery. A model of ecosystem degradation called the ball and cup model has been suggested to describe the degradation process (Hobbs and Suding ed. 2009). Figure 1 provides a generalized representation of this model. It should be noted that as ecosystems are places with complex interactions, the degradation processes will also be complex. A multi-dimensional model might be a better representation of what actually goes on. However, such a model would be difficult to visualize so the two dimensional illustration shown in Figure 1 provides a way of understanding how degradation happens and the consequences of that degradation.

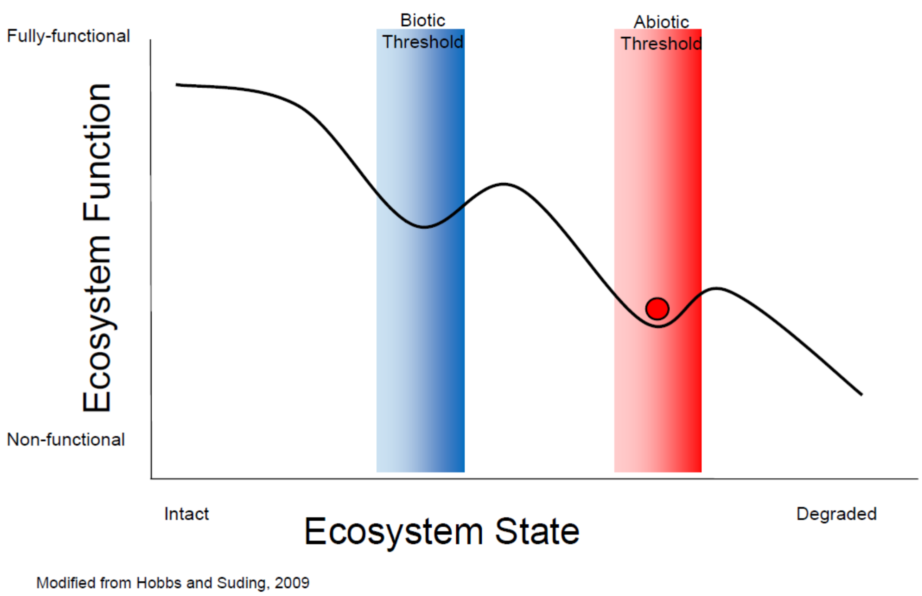

Figure 1. Ball and cup model of habitat degradation.

The ecosystem at the Sibco site has been degraded by abiotic (fire) and biotic (invasive species and cattle) elements. In both cases, the treatments designed to restore the ecosystem (Section 2.0) must be robust enough to move the ecosystem out of the "cup" in which it has settled. The invasive species at the Sibco site are a response to this "cup". The restoration treatment must move the ecosystem out of the "cup" and re-establish a functional vegetation cover that will resist the tendency for the ecosystem to slip back into the "cup".

2.0 HABITAT RESTORATION PLAN

Restoration of the Sibco property needs to start with the re-establishment of the natural (or anthropogenic) disturbance regimes that maintained this ecosystem historically. Fire has been used in the restoration of Garry Oak ecosystems in the face of competitive alien invasive grasses and has been shown to reduce competition as long as native species are planted into the burned areas soon after the burning (Photograph 5, MacDougall 2002; MacDougall 2004). Using fire, as a restoration method however has been seen as a problem in many areas including the Okanagan. Obtaining social license to conduct landscape level burns can be difficult, but very beneficial. By burning excess biomass, the natural fires that will occur will not be as damaging. Details on the implementation of these suggestions are provided in the following section.

Photograph 5 (left) and 6 (right). Anthropogenic fire has been part of many ecosystems for millennia (left). Fire in many areas is not socially acceptable. Mowing (right) can be used as a surrogate for burning but the ecological consequences are slightly different.

Mowing can be used as an effective treatment to replace fire and to manage biomass production in grassland ecosystems (Photograph 6, MacDougall et al. 2004). Mowing must be conducted in concert with other restoration efforts and timed to avoid degradation of the species that are desired. The Sibco site was degraded to the point where the fire that swept the area in 2007 burned the root crowns of the antelope brush. This has removed an important ecosystem element. The restoration strategy must provide for the re-establishment of antelope brush. It would be helpful if the native species that are important to the maintenance of the Behr's hairstreak butterfly could be re-established in the degraded area, although this might have to wait until the foundations of the ecosystem have been re-established.

Addressing the invasive species that have established on the Sibco site will need to be one of the initial treatment efforts. Over the first growing season, the restoration program should be focused on the degradation of the invasive species populations. It is expected that in addition to the invasive species that currently occupy the site, the soil seed bank contains numerous viable seeds of many of the invasive species that currently occur on the site. Invasive species can establish and occupy a site that has been degraded, damaged or destroyed, creating an alternative successional trajectory that results in successional stagnation (Kimmins 1978). Invasive species at the Sibco site have settled into the "cup" of the biotic filters shown in Figure 1. Significant effort will be required to move the ecosystem from this degraded state. Timely mowing can be an effective treatment to address the invasive species. To be effective the mowing must be conducted before the annual weedy species set seed and at a time when the energy reserves of perennial invasive species are low. Also the cutting of perennial species needs to continue through the growing season, so that the absence of significant photosynthetic activity will result in the death of the plant. Figure 2 provides a graph of this process. If the initial mowing is conducted as the annuals start to flower in mid-June and repeated cutting of re-sprouting perennial invasive species is conducted in early July, mid-July, at the end of July or early August, then again in mid-August and at the end of August, mid-September and at the end of September it is very probable that these plants will die over the winter. Understanding the ecology and physiology of the invasive species as well as the native ecosystem provides a context for the design of effective invasive species management scenarios (Polster 2004).

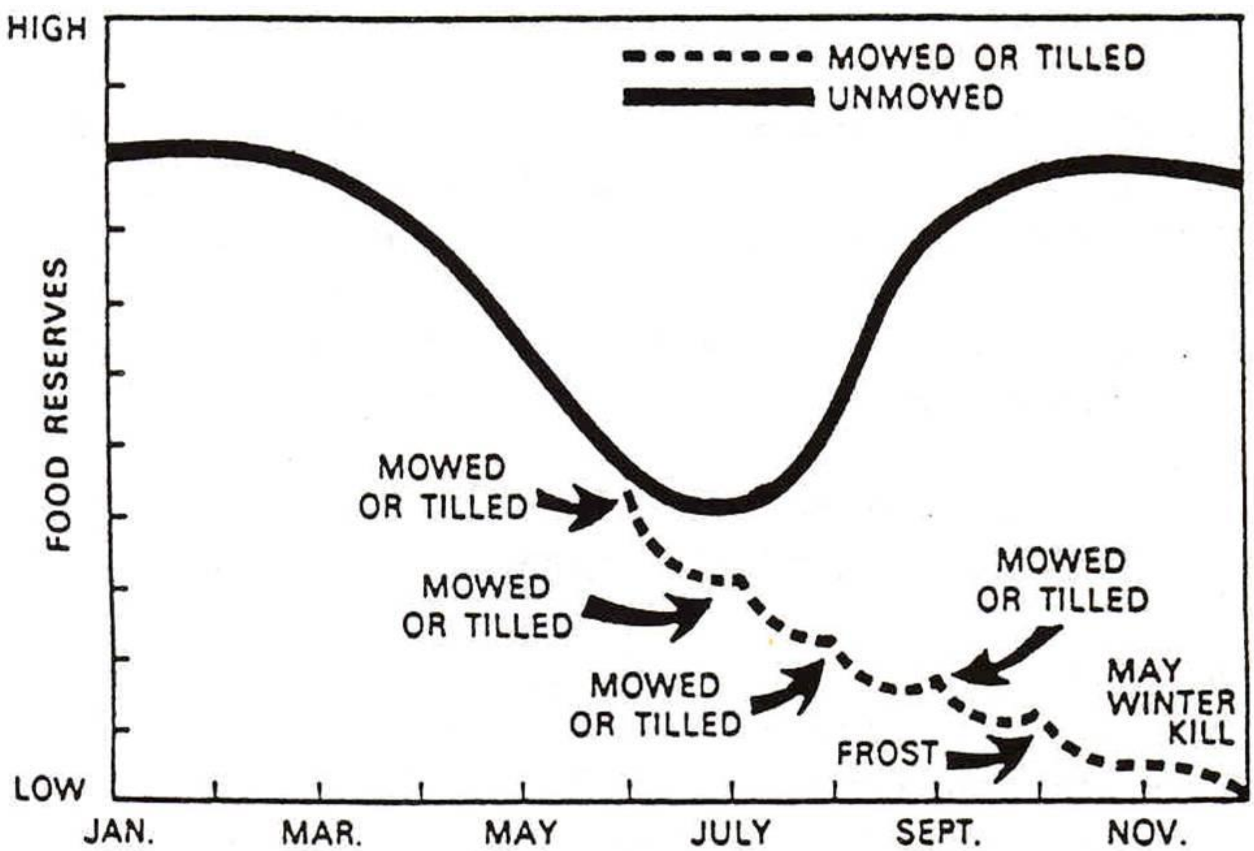

Figure 1. Plant energy reserves of perennial species can be reduced through repeated cutting (or tilling) during the growing season, resulting in the death of the plant. This can be an important selective method of removing invasive species without excessive soil disturbance or degradation of remaining native species.

In addition to the focus on removing invasive species, the restoration efforts during the first year of the recovery program will need to include collecting suitable native species seed. The seed will be used in the second and subsequent years to re-establish the fabric of the native ecosystem. There are a variety of ways of collecting native seed. Where large stands of relatively pure native species can be found, machines that operate like large string weed whips can be used (see the Canadian made hand held harvesters at http://www.prairiehabitats.com/Harvester_Hand_Held.html). Seeds can also be harvested by hand, but this can be very tedious if large quantities of seed are needed. Seed harvesting crews can be hired but care needs to be taken to ensure personnel know the species to harvest and how to handle the seed.

Seed collections will need to be made in areas where the desirable species occur in the proportions that are suitable for the Sibco site. Since grasses make up the framework (fabric) of this ecosystem, the seed collection should focus on species such as needle and thread grass (*Hesperostipa comata* (Trin. & Rupr.) Barkworth), bluebunch wheatgrass (*Pseudoroegneria spicata* (Pursh) A. Love), red three-awn (*Aristida purpurea* Nutt.) and junegrass (*Koeleria macrantha* (Ledeb.) Schult.). By re-building the basic fabric of the ecosystem the specialized native species that support the Behr's hairstreak can be established in this fabric. Without the fundamental fabric of the ecosystem, and all the myriad of species from fungi to invertebrates and bacteria/viruses, that compose that fabric, the specialized species that support rare species will not persist and a weedy ecosystem will result.

The second year of treatment can consist of seeding in the desired species, if the invasive species are well under control. Photograph 7 shows a site in Wisconsin where tall grass prairie species were seeded in using mechanical seeding equipment. Rangeland seeders are commonly used for this purpose. The British Columbia Ministry of Agriculture has used rangeland seeders to improve rangeland forage and may be able to provide information on the availability of such machines for use at the Sibco site.

Photograph 7 (left) and 8 (right). Tall grass prairie ecosystem restoration in Wisconsin (left) has used rangeland seed drills to re-establish the native prairie from lands used for agriculture. Planting grass plugs in a Garry Oak ecosystem (right). Over 100,000 plugs have been planted to "re-stitch the fabric of this ecosystem".

Once the fabric of the ecosystem is re-established and monitoring has shown that the perennial grasses and forbs are well established (at least 2 full growing seasons after seeding), antelope brush can be replanted (Photograph 8). The antelope brush will make subsequent mechanical treatments more tedious so it is best if the ecosystem is well established before the antelope brush is planted. Antelope brush can be planted as nursery grown plugs at a density of about 500 stems/ha (one plant every 20 m^2). In many cases, the existing antelope brush stands are too dense and hence support wildfires that destroy the root crowns of these plants. Keeping a wider spacing will allow mowing to be used to maintain a reasonable level of dead grass fuels and avoid the accumulation of biomass that can result in excessively hot fires. Other shrubs such as rabbit brush (*Ericameria nauseosa* (Pall. ex Pursh) G.L. Nesom & Baird), smooth sumac (*Rhus glabra* L.), gray horsebrush (*Tetradymia canescens* DC.), oceanspray (*Holodiscus discolor* (Pursh) Maxim.) can be planted with the antelope brush.

Specialized native species (e.g. yarrow (*Achillea millefolium* L.) and buckwheat species, probably parsnip-flowered buckwheat (*Eriogonum heracleoides* Nutt.) or snow buckwheat (*Eriogonum niveum* Douglas ex Benth.)), that have historically supported rare butterfly populations can be planted at this time as well. There may be an advantage in planting these species in patchy distributions as that can help with ensuring pollination and reduce competition. For instance a patch of yarrow that is about a square metre in size could consist of about 100 plants. Maintaining these patches of nectaring plants within 10 or 20 m of each other may help to support rare butterflies. These plants can be grown from seeds by native plant nurseries and planted as small rooted plugs. Rare plants such as deltoid balsamroot (*Balsamorhiza deltoidea* Nutt.) have been established from plugs that were grown from seeds at Garry oak ecosystems on Vancouver Island (see Photograph 9).

Photograph 9. A total of 80 Deltoid Balsamroot (large yellow flowers) plants were grown as 1 year old plugs from seeds. These were planted on this site in the fall of 2004. Although some of the newly planted seedlings died, enough of the plants succeeded and have now (2014) reached a point where the mature plants are setting seed and producing offspring.

The specialized native species that support the Behr's Hairstreak butterfly will need to be replanted on the Sibco site once the major tasks of restoration already described have been completed. These species can be grown by either local native plant suppliers such as Grasslands Nursery (http://www.grasslandsnursery.ca/), Sagebrush Nursery (http://sagebrushnursery.com/) or by coastal suppliers such as NATS Nursery (http://natsnursery.com/) from seeds collected at or near the Sibco site. Seed collections should be made by workers that have knowledge of the species being sought as well as potential weedy species that might contaminate collected seed.

The restoration strategies outlined in this report are designed to:

1. Identify the ecosystem maintaining ecological processes that have been degraded;
2. Address the constraints (filters) that are preventing the natural recovery of the ecosystem;
3. Rebuild the fabric of the ecosystem; and
4. Re-establish the plant species and conditions that can contribute to the successful maintenance of invertebrate populations.

By following these steps, the restoration strategy outlined here seeks to create a healthy, resilient ecosystem that fits within the ecological context of the Sibco site. Maintenance of that ecosystem (outlined below) will be required to ensure the ecosystem damaging elements that have degraded the Sibco site (e.g. the excessively hot fire that swept through the area).

3.0 Ecosystem Management

The established Antelope Brush ecosystem will need to be managed to avoid the problems of hot fires. Mowing is suggested as the best method for treatment of the established ecosystem. Mowing can be conducted every few years when the seeds of the native grasses are mature (late summer) so that the mowing spreads the native species seeds. Mowing has been used in Garry oak ecosystems as a replacement for fire and to help spread the seeds of planted native grasses and to reduce weed occurrence. This can help in the maintenance of the native grasses and can help avoid the problems of weedy species re-establishing and the occurrence of excessive build-up of biomass.

Monitoring will need to be conducted throughout the restoration program and to check on the continued health of the established ecosystem. Photograph 9 shows a system of monitoring that was used effectively at a Garry Oak ecosystem for about 10 years throughout the restoration period. Transects were established at suitable locations in the restoration area. At each transect location a metal plate was driven into the soil to mark the location of the start and finish of the transect. This plate can be easily re-found using a standard surveying metal detector. Plots (1 m^2) were established at 5 m intervals along each transect. A 50 m tape was stretched between the start and finish of the transect so that plot locations can be found. The plot corners were marked with a 30 cm spike with a washer on the top. These can also be found with a metal detector, although measurements along the tape provide approximate locations of the pins. At every plot a full listing of the species present was made along with a visual estimate of the cover and abundance following the techniques described in Field Manual for Describing Terrestrial Ecosystems (BC Ministry of Forests and Range 2010). Vegetation data can then be monitored to determine if the restoration treatments are having the desired effects. A similar program could be conducted at the Sibco site for about 10 years following the restoration treatments.

Photograph 9. Fifty meter long transects with 1 m^2 plots at every 5 meters have been used at a Garry Oak ecosystem restoration program to monitor the progress of the restoration work. Within the 1 m^2 plots smaller (50 cm by 20 cm) were established to document minor vegetation.

4.0 APPROXIMATE COSTS FOR CONDUCTING RESTORATION WORKS

The costs of conducting ecological restoration work will depend on who does the work and the extent of the work that is conducted. In some cases, dedicated local volunteers can be engaged to conduct the restoration work and to maintain it following completion of the initial work. However, these situations are rare and in most cases, restoration work is conducted by one or more contractors who are hired by the site managing organization or by a local non-profit group that has obtained funding to oversee the restoration work. In these cases, there are costs associated with the various elements of the work. These are discussed below.

The initial timely mowing will be the first cost that is incurred. A local farmer with a tractor mounted deck mower can probably do this work reasonably. There may be some added expenses initially of getting rid of mowing obstructions (e.g. old barbed wire or old tires or other obstructions). A cost of about $75/hour could be expected for mowing with a tractor with an estimated productivity of 4 hours/hectare. Ensuring that the mowing can be conducted at the right times will be essential to the success of the program. Where repeated cutting is used to control perennial species, the time between cuttings is critical to the success of these treatments. Two to three weeks is generally found to be the optimum time between cuttings.

Collecting seeds can be a tedious task. However, if contracts are written to provide a certain volume (generally weight or seed number) of pure live seed then native seed can be obtained from local areas for a reasonable cost. Seed collected for the initial work at the Somenos Garry Oak Protected Area (shown in various photographs above) that included 20,000 seeds of each of five native grasses, one sedge and four forbs (including one listed species) cost $5,000. The costs for seed collection should include seed cleaning as well as germination testing hence the use of a payment term that is based on the weight or number of pure live seed. Otherwise there is no incentive to avoid weeds and other materials. There will need to be enough seed collected so that there can be a seeding rate of about 100 pure live seeds per square meter. Since seed weights differ, and the proportion of different species should reflect the desired final cover, the weight of seed from different species will differ. If possible, it would be best to collect a mix of seeds using a seed harvesting machine as discussed above.

The initial seeding to rebuild the fabric of the ecosystem will need to be conducted by a tractor pulled rangeland seed drill. There may be local farmers who have such equipment and would be willing to work on the Sibco site. The hourly rate and performance (ha seeded/hr.) of seeding is expected to be about the same as for mowing and it may be that the person who does the mowing can be contracted to do the seeding as well.

Costs for growing and planting the 1+0 (1 year in the nursery and no years in the lining bed) plugs of woody species and/or forbs that will enhance butterfly use of the area will depend on a variety of factors. However, experience over a number of different projects in a number of different locations has found that budgeting $1/plant grown and planted is about right. In most cases, 415 Styro-block container grown plants will be best. If the planting consists of 500 stems/ha of Antelope Brush and an equal number of other species, the total cost of obtaining and planting plugs could be about $1,000/ha. Standard tree planting companies (Brinkman, Artisan, Treeline, etc.) tend to be the most effective in planting stock on restoration sites.

Monitoring of the restoration treatments is an essential part of the restoration program. Monitoring provides an indication of the success or failure of the restoration work. In addition, carefully contracted monitoring programs can provide information on the occurrence of weed species or other problems that might arise. In addition reports from the monitoring can provide a long term record of how the ecosystem developed as well as providing indications of what might be changed in future restoration programs. Costs for monitoring restoration work vary, but a budget of $20,000/year should provide ample funding for a reasonable monitoring program.

5.0 CONCLUSIONS

Restoration of the Sibco antelope brush site will require that the degraded ecosystem be treated with sufficient vigour so that the currently established weedy cover is dislodged and a cover of suitable native species can be established. The first phase of the restoration program should therefore focus on the treatment of the invasive species. Once these are under control, re-establishment of the native ecosystem components can be conducted.

A program of aggressive range seeding is recommended as a means of re-establishing the understory of the antelope brush ecosystem. Once this is well established and there is assurance that the invasive species have been brought under control, re-planting with antelope brush and other shrubby species (e.g. saskatoon) at wide spacing would be reasonable. Monitoring and active management will be required to maintain this ecosystem.

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