CHAPTER 2: Impact

Economics

Yellow starthistle is considered one of the most serious rangeland, grassland, and wildland weeds in the northwestern United States. It can also infest grain fields and other agricultural areas where seeds can contaminate grain harvest and lower crop quality and value.

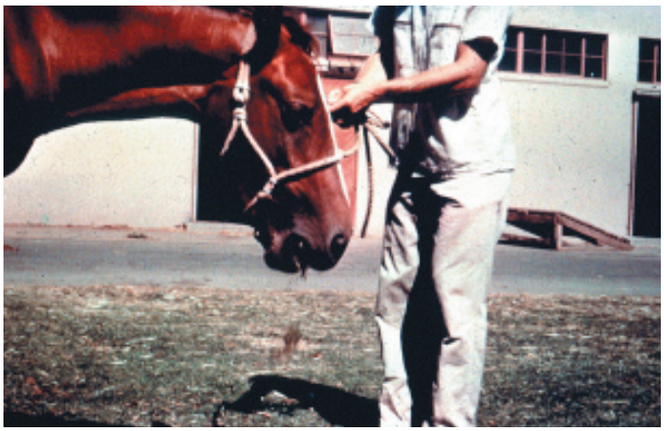
Taxpayers incur significant direct costs for both regional and statewide control of yellow starthistle by public agencies on public lands, including costs of materials and labor for treatments such as prescribed burning, herbicide application and mowing. In California, about 0.5 million acres of yellow starthistle are managed at about $25 per acre for a cost of about $12.5 million annually in management. Taxpayers also fund the California Department of Food and Agriculture's biological control program for statewide management of this noxious weed (Jetter *et al*. 2003).

Yellow starthistle is a major consumer of groundwater, costing the state millions of dollars in lost water for wildlife, agriculture and municipal uses (Gerlach 2004). It can also reduce land value and reduce access to recreational areas (DiTomaso *et al*. 1998b, Roché and Roché 1988).

On military bases such as Fort Hunter Liggett, yellow starthistle can severely impact training exercises and can impair the use of equipment (e.g., snagged parachutes, torn clothing) or clog air filters on vehicles. In addition, yellow starthistle can cause mechanical injury to humans (particularly to the face) when the spines are encountered (Miller 2003).

Failure to control yellow starthistle may impose substantial costs on neighboring properties (Jetter *et al*. 2003). If a rancher, public land manager, or homeowner does not control yellow starthistle, it may spread onto surrounding land, whether rangeland, farmland, roadside, or wilderness area.

These impacts are explored in more detail in the following sections.



Horse with chewing disease. *Horses poisoned by yellow starthistle develop a neurological condition and mouth ulcers. (Photo: J. McHenry)*

Rangelands

Although no comprehensive economic assessments have been conducted for yellow starthistle, millions of dollars in losses occur annually from interference with livestock grazing and forage harvesting procedures, and reduced yield and forage quality of rangelands (Callihan *et al*. 1982, Roché and Roché 1988). In a study conducted at the Sierra Foothill Research and Extension Center, it was estimated that a 20-31% infestation of yellow starthistle reduced livestock carrying capacity by about 10-15% (Connor 2003). It was also speculated that heavier infestations could reduce the carrying capacity of rangeland by over 50%. Over the entire state of California, it is estimated that yellow starthistle control expenditures and loss in forage value result in combined losses of 6% to 7% of the value of pasture (S. Schoenig, California Department of Food and Agriculture, pers. comm.).

Cattle, sheep (*Ovis*), and goats (*Capra*) will graze on yellow starthistle in early spring and up to the bolting stage. Because of the spiny flower heads, livestock will not graze yellow starthistle once it begins to mature (Maddox *et al*. 1985, Sheley *et al*. 1999a, Thomsen *et al*. 1993, 1996a). Thus, yellow

YSTMgmt(FINAL).indd 4 10/12/06 12:49:25 PM

starthistle can greatly increase the cost of managing livestock. Although the nutritional component of yellow starthistle leaves is highly digestible by ruminants during the growing season (Callihan *et al*. 1995), its nutrient value declines as the plants mature. Measures of protein and acid detergent fiber (ADF) content indicate that yellow starthistle has acceptable nutritional value as a component of a ruminant's diet (Thomsen *et al*. 1989). In the bolting to early bud stage, protein content was 11 to 13% and ADF was 28 to 32%. However, an analysis of the nutritional status of cattle manure in the fall indicated that yellow starthistle-infested pastures contain considerably less crude protein and total digestible nutrients compared to uninfested pastures (Barry 1995) and do not provide the required quality of forage in summer and fall (Connor 2003).

Toxicity to Horses

Numerous reports have characterized the toxic effect of yellow starthistle on horses (Cheeke and Shull 1985, Cordy 1978, 1954a, b, Kingsbury 1964, Larson and Young 1970, Martin *et al*. 1971, McHenry *et al*. 1990, Mettler and Stern 1963, Panter 1990, 1991, Young *et al*. 1970). When ingested by horses, yellow starthistle causes a neurological disorder of the brain called nigropallidal encephalomalacia or "chewing disease." Continued feeding results in brain lesions and mycosal ulcers in the mouth (Kingsbury 1964). There is no known treatment for horses that have been poisoned by yellow starthistle. In most cases the animals die from starvation or dehydration (Panter 1991).

The poisoning is a chronic condition affecting the horse primarily after the animal has ingested fresh or dried plant material over an extended period, typically a 30 to 60 day period, at cumulative fresh weight of 60 to 200% their body weight (Panter 1990, 1991). Cheeke and Shull (1985) reported the lethal dose to be 2.3 to 2.6 kg yellow starthistle per 100 kg of body weight per day. The clinical signs of poisoning include drowsiness, difficulty in eating and drinking, twitching of the lips, tongue flicking, and involuntary chewing movements. The peak months of poisoning are midsummer (June-July) and more importantly mid-fall (October-November) (Cordy 1954a, b, 1978). The summer peak is associated with the rapid growth phase following spring and the second peak is likely due to autumn rainfalls that stimulate growth of plants surviving through the summer.

It is suspected that repin, a sesquiterpene lactone isolated from yellow starthistle, may be responsible for symptoms in horses (Akbar *et al*. 1995; Merrill and Stevens 1985). In another study, researchers provided evidence suggesting that amino acids aspartate and glutamate may also be involved (Roy *et al*. 1995).

Yellow starthistle poisoning is generally most dangerous when it is the only feed available or when it is a significant contaminant of dried hay. In some cases, however, horses acquire a taste for yellow starthistle and seek it out even when other forage is available (Panter 1991). In northern California in 1954, it was estimated that at least 100 cases of horse poisoning by yellow starthistle occurred annually (Cordy 1954b). Because starthistle toxicity is generally recognized today, veterinarians and researchers note that cases of yellow starthistle poisoning in horses are now relatively uncommon (Segall, UC Davis School of Veterinary Medicine, pers. comm.).

Interestingly, it appears that only horses are affected by ingestion of yellow starthistle. Mules and burros seem unaffected. However, all grazing animals can sustain damage to their eyes from the plant's long, sharp spines (Carlson *et al*. 1990).

Roadsides and Recreational Areas

In addition to rangeland, pastures and grasslands, yellow starthistle is the most important roadside weed problem in much of central and northern California (Anonymous 1999, Maddox *et al*. 1985).

Yellow starthistle along roadside. *Infestations spread through equipment and vehicles. Roadside infestations often represent the leading edge of spread.*

YSTMgmt(FINAL).indd 5 10/12/06 12:49:25 PM

Its spread along roadsides probably occurs with the movement of contaminated soil, vehicles and equipment, particularly mowers. These roadside infestations tend to represent the leading edge of movement into new areas, where they then spread into grassland and rangeland habitats (Schoenig 1999).

Many recreational areas, including trails and campgrounds, streamsides, hunting areas, and recreational vehicle parks are contaminated with yellow starthistle. Such infestations reduce or eliminate access, resulting in an economic impact on both private and public areas.

Wildlands

Yellow starthistle infestations may reduce wildlife habitat and forage, displace native plants, and decrease native plant and animal diversity (Sheley and Larson 1994). Dense infestations also threaten natural ecosystems and nature reserves by fragmenting sensitive plant and animal habitat (Scott and Pratini 1995).

Severe infestations of yellow starthistle can form near-monotypic stands, dramatically impacting plant diversity in these areas. In a study at Sugarloaf Ridge study in Sonoma County, California, total plant diversity increased significantly when yellow starthistle was controlled using multiple years of prescribed burning compared to unburned plots (DiTomaso *et al*. 1999a). This increase in diversity remained higher than untreated plots for two years following the final treatment (Kyser and DiTomaso 2002).

Hastings and DiTomaso (1996) suggest that invasion of California grasslands by yellow starthistle may be caused, in part, by fire suppression and reductions in fire frequency in these ecosystems. At Sugarloaf Ridge, for example, yellow starthistle invaded grasslands in the 1980s following 60 years of fire suppression. Once present, heavy infestations of yellow starthistle may change the fire regime by changing fuel characteristics at a given site. This may keep the community perpetually off-balance and not allow the re-establishment of native species. Once established as a dense stand on a site, yellow starthistle does not provide sufficient fine fuel to carry fire when still green (Hastings and DiTomaso 1996). Later in the season, dried skeletons of yellow starthistle can provide fuel for late-summer wildfires.

Yellow starthistle in wildlands. *Many natural areas in California are heavily infested with yellow starthistle. At Sugarloaf Ridge State Park, grasslands are dominated by starthistle. This photo shows the potential of prescribed fire in controlling starthistle (background left, compared to unburned foreground).*

Water Consumption

Recent studies indicate that yellow starthistle significantly alters water cycles and depletes soil moisture reserves in annual grasslands and foothill woodland ecosystems in California (Benefield *et al*. 1998, DiTomaso *et al*. 2000b, 2003b, Dudley 2000, Enloe 2002, Enloe and DiTomaso 2004, Gerlach *et al*. 1998) and in perennial grasslands in Oregon (Borman *et al*. 1992). Because of its high water usage, yellow starthistle increases water conservation costs and threatens both human economic interests and native plant ecosystems (Dudley 2000). The California Water Resources Control Board has acknowledged that control of weeds could significantly conserve water. Based on a conservative estimate of starthistle coverage in the Sacramento River watershed, Gerlach (2004) estimated that yellow starthistle may cause an annual economic loss of $16 to $75 million in water conservation costs alone. This amounts to approximately 46,000 acre-feet (15 billion gallons) of water loss from the Sacramento River watershed each year through transpiration by yellow starthistle (Gerlach 2004). An estimate for Siskiyou County suggested that the potential water loss to yellow starthistle would be more than 26,400,000 gallons of water per year (Enloe 2002).

Depletion of soil moisture by yellow starthistle can result in a loss of 15 to 25% of mean annual

YSTMgmt(FINAL).indd 6 10/12/06 12:49:26 PM

precipitation (Gerlach 2004). Because these infestations use deep soil moisture reserves earlier than associated natives such as blue oak (*Quercus douglasii*) or purple needlegrass (*Nassella pulchra*), native species can experience drought conditions even in years with normal rainfall (Benefield *et al*. 1998; Gerlach *et al*. 1998).

Excessive water use by yellow starthistle could decrease water levels in streams and lakes, reducing water availability for recreational activities. Decreased stream flows may also reduce or delay spawning of anadromous fish and degrade fisheries water quality through effects of reduced flow on water temperature (Jetter *et al*. 2003).

Bee Industry

Not every aspect of yellow starthistle is detrimental. The weed is regarded as an important honey plant and late-season food source for bees in California (Edwards 1989, Goltz 1999). In 1959, about 150,000 bee colonies utilized yellow starthistle as a source of pollen and nectar. At that time honey from yellow starthistle was valued at $150,000 to $200,000 annually (Maddox *et al*. 1985). No recent economic estimates have been made for the value of yellow starthistle in honey production.

Bees extract yellow starthistle nectar. *A range of bees use the nectar, including bumble bees (pictured here) and commercial honey bees. (Photo: B. Villegas)*

YSTMgmt(FINAL).indd 7 10/12/06 12:49:29 PM