

SPECIES: *Atriplex gardneri*

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Figure 1—Gardner's saltbush fruits. Image by Matt Lavin from Bozeman, Montana, USA. Used with permission.

SUMMARY

SPECIES: *Atriplex gardneri*

This Species Review summarizes information on the fire effects and related ecology of Gardner's saltbush that was available in the scientific literature as of 2020.

Gardner's saltbush is a member of a complex of taxa that are intermediate between herbaceous and shrub forms (i.e., half-shrubs). Taxa within the complex hybridize readily, confounding species identification and classification. There is disagreement among systematists as to placement of taxa sometimes classified as Gardner's saltbush.

Gardner's saltbush is distributed from southeastern British Columbia east to southwestern Manitoba and south to Colorado. It grows in semiarid and temperate climates and is drought and salt tolerant. It is common to dominant on sites with fine-textured, saline soils, especially clay flats and basins. Gardner's saltbush dominates or codominates many salt desert shrublands, and it is a component of some sagebrush and mixed-grass prairie communities.

Gardner's saltbush reproduces after fire and other top-killing events primarily by sprouting from the root crown and roots. It also reproduces from seed, from persistent aerial and soil-stored seed banks. Its fruits may remain viable on the plant for 1 to 2 years. The seeds are dormant upon dispersal, with high levels of dormancy and complex, multiple mechanisms of dormancy. The seedlings are most competitive on saline soils. Gardner's saltbush occurs in all stages of succession.

Information on Gardner's saltbush response to fire was scarce and anecdotal as of 2020. Due to sparse fuels, salt desert shrublands rarely burn. When fires do occur in Gardner's saltbush communities, they are stand replacing. Gardner's saltbush is relatively inflammable, and it is planted in fuelbreaks and sagebrush communities to stop or slow fire spread.

Gardner's saltbush communities are vulnerable to establishment and spread of halogeton (an invasive annual forb), especially during periods of shrub die-back. Incidents of shrub die-back may increase with climate change. Gardner's saltbush communities are apparently resilient to postfire establishment and spread of cheatgrass and other invasive annual grasses due to saline soils, but other communities with Gardner's saltbush may experience such postfire invasion.

Gardner's saltbush provides palatable, year-round browse for wildlife and livestock. It is fairly resistant to browsing pressure, although its cover and frequency are reduced in areas with heavy or continuous browsing pressure.

INTRODUCTORY

SPECIES: *Atriplex gardneri*

- [Taxonomy](#)
 - [Synonyms](#)
 - [Life Form](#)
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Literature cited in this Species Review include these reviews: [[65,66,67](#)]. Common names are used throughout this review. See [table A1](#) for a complete list of plant species mentioned.

FEIS Abbreviation

ARCGLA

Common Names

Gardner's saltbush

Taxonomy

The scientific name of Gardner's saltbush is *Atriplex gardneri* (Moq.) D. Dietr. [27,31,45,52,54,103,106,108] (Amaranthaceae) [45,52,54].

Hybrids: Gardner's saltbush is a member of the closely aligned *Atriplex canescens*-*A. nuttallii* taxonomic complex [31,39,108], which includes saltbush taxa that are intermediate between herbaceous and shrub forms (i.e., half-shrubs) [39]. Taxa in this complex intergrade genetically and morphologically [40,88,97,98,107,108,109], although hybridization is "occasional" enough to maintain species distinctions [109]. Within the complex, Gardner's saltbush hybridizes most commonly with fourwing saltbush [31,96,97,107], mat saltbush, and shadscale saltbush [31,39]. Hybrid swarms, and introgression among hybrids and parents, confound species identification and classification of taxa within the complex [31,98,107]. There is disagreement among systematists as to placement of taxa sometimes classified as Gardner's saltbush (see table 1).

Table 1—Nomenclature for taxa also assigned as varieties of Gardner's saltbush.

<p>for <i>Atriplex</i> × <i>aptera</i> A. Nelson, moundscale [52,103]: <i>Atriplex gardneri</i> var. <i>aptera</i> (A. Nelson) S. L. Welsh & Crompton, Nelson's saltbush [31,45,109]</p> <p>for <i>Atriplex bonnevillensis</i> C. A. Hanson, Bonneville saltbush [52,103]: <i>Atriplex gardneri</i> var. <i>bonnevillensis</i> (C. A. Hanson) S. L. Welsh [31,45,108,109]</p> <p>for <i>Atriplex cuneata</i> A. Nelson, valley saltbush [52,103]: <i>Atriplex gardneri</i> var. <i>cuneata</i> (A. Nelson) S. L. Welsh, Castle Valley saltbush [31,45,108,109]</p> <p>for <i>Atriplex falcata</i> (M. E. Jones) Standl., sickle saltbush [52,103]: <i>Atriplex gardneri</i> var. <i>falcata</i> (M. E. Jones) S. L. Welsh, Jones' saltbush [31,45,108,109]</p> <p>for <i>Atriplex robusta</i> Stutz, M. R. Stutz & S. C. Sand., robust saltbush [45,103]: <i>Atriplex gardneri</i> var. <i>robusta</i> (H. & M. Stutz) N. & P. Holmgren) [52]</p> <p>for <i>Atriplex tridentata</i> Kuntze, basin saltbush [52,103]: <i>Atriplex gardneri</i> var. <i>utahensis</i> (M. E. Jones) Dorn [31,108,109]</p> <p>for <i>Atriplex welshii</i> C. A. Hanson, Welsh's saltbush [52,103]: <i>Atriplex gardneri</i> var. <i>welshii</i> (C. A. Hanson) S. L. Welsh [31,45,109]</p>
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Synonyms

- for *Atriplex gardneri* (Moq.) D. Dietr.:
Atriplex nuttallii S. Watson subsp. *gardneri* subsp. *gardneri* (Moq.) H.M. Hall & Clem. [39]
Atriplex nuttallii S. Watson var. *gardneri* (Moq.) R. J. Davis

Life Form

Shrub-forb

DISTRIBUTION AND OCCURRENCE

SPECIES: *Atriplex gardneri*

- [GENERAL DISTRIBUTION](#)
- [SITE CHARACTERISTICS AND PLANT COMMUNITIES](#)

GENERAL DISTRIBUTION

Gardner's saltbush is distributed from east-central British Columbia [54] east to southwestern Manitoba and south to Colorado (fig. 2) [31,51,103].

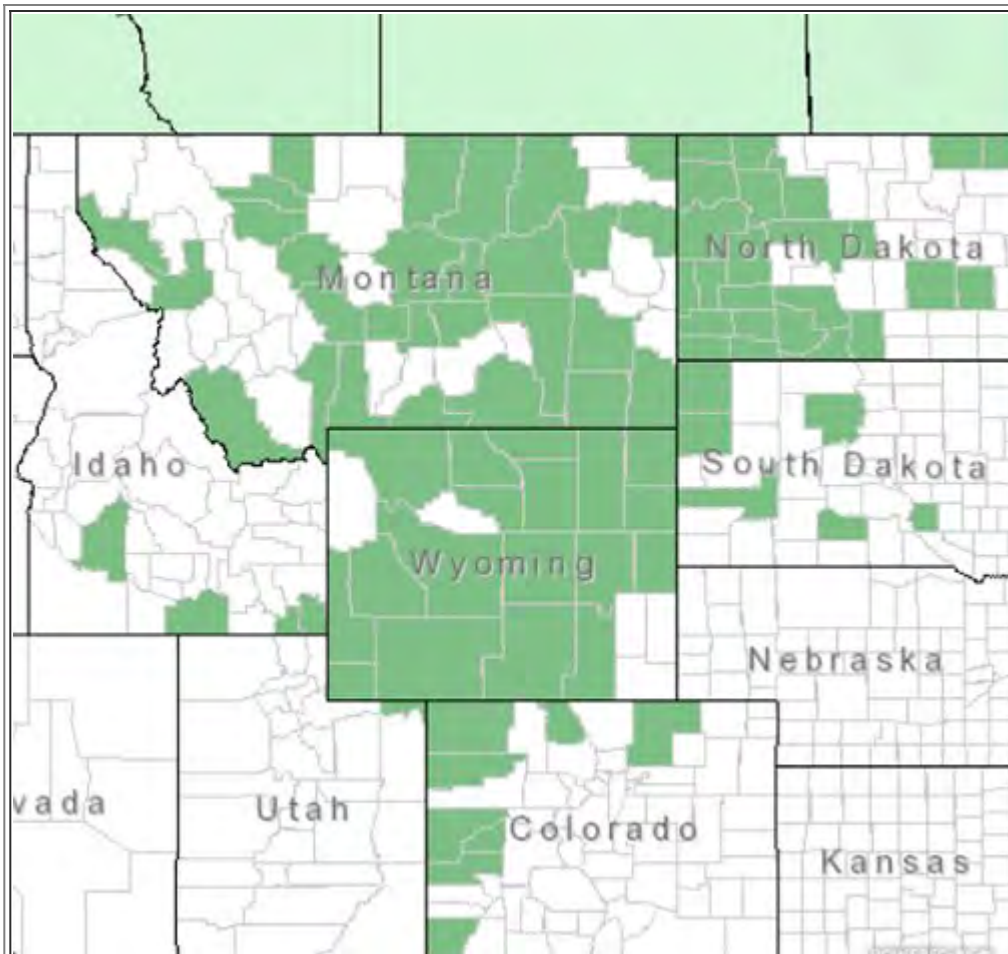


Figure 2—Gardner's saltbush distribution. Map courtesy of the U.S. Department of Agriculture, Natural Resources Conservation Service. [2020, August 8] [103].

SITE CHARACTERISTICS AND PLANT COMMUNITIES

Site Characteristics: Gardner's saltbush grows in semiarid and temperate climates [70,93]. Across its distribution, summers are generally hot, and freezing temperatures are common in winter. Mean annual precipitation across its distribution ranges from 130-330 mm [70]. Most of the species' distribution falls in areas with a continental climate, although monsoons occur in Colorado. Within its distribution in Montana and Wyoming, about two-thirds of the annual precipitation falls in spring and early summer. Within its distribution in Colorado, over half the precipitation occurs during late summer monsoons, which are accompanied with high-intensity thunderstorms [70].

Gardner's saltbush is drought [48,86] and salt tolerant [24,86,88], and it grows primarily in dry [62] and saline soils [31,86]. A study in the Pryor Mountains of Wyoming found Gardner's saltbush-bud sagebrush communities had the lowest soil moisture among four adjacent communities [62]. Gardner's saltbush is mostly an upland species, growing on sites where the water table is well below 1 m [110]. However, it may grow on infrequently [42] or periodically flooded [62,93] sites, in soils with poor infiltration [42,70] and seasonally pooling water, on wet soils with shallow water tables [42], and in riparian areas [62], especially along alkaline streams [39]. For

example, iodinebush-Gardner's saltbush communities in the Northern Great Basin occur in intermittently flooded playa basins. The soils are saline and may have a salt crust [70]. In Wyoming and eastern Montana, black greasewood-Gardner's saltbush communities occur in areas that are usually very dry but flood intermittently [91].

Salt desert shrublands occur where soils are too saline and/or dry for most sagebrush taxa [76]. Salt desert shrublands dominated by Gardner's saltbush are most abundant on alkaline [70] clay soils [60,65] with high concentrations of soluble salts [10,70]. These communities often experience high erosion rates due to poor infiltration and high runoff [70], and their soils are generally heavier, finer-textured, and more basic than soils where big sagebrush or fourwing saltbush dominate [42].

Gardner's saltbush is common to dominant in plant communities with fine-textured, saline soils in much of the Intermountain Region and the western Great Plains [31,70]. In southern Saskatchewan, Gardner's saltbush-blue grama associations occur on south-facing slopes, in sandy soils with cobblestones (Banerjee et. al 1999, cited in [89]). In the Big Horn Basin and Pryor Mountains of Montana and in Wyoming, the birdfoot sagebrush-Gardner's saltbush dwarf-shrub association occurs on arid alluvial fans and terraces with mostly poorly drained, fine-textured, alkaline soils. Less frequently, the association occurs on moderate slopes of outwash plains. Soils are clay or silty-loam alluvium derived from shales and claystone, with lesser amounts of sandstone [70]. In Montana, Gardner's saltbush/Nuttall's povertyweed communities are restricted to arid sites with deep clay soils derived from shale or bentonite deposits. These soils have extremely low infiltration, with gentle slopes and high rates of erosion. Gravel and salt deposits are often present on the soil surfaces [88]. In eastern Montana and the Dakotas, Gardner's saltbush grows on shale badlands derived from siltstones and mudstones; these are highly erodible soils with high clay content [69]. In Gardner's saltbush communities of the Dakota and Wyoming Badlands, soils are derived from shale or alluvium [70]. Gardner's saltbush occasionally grows in sandy soils [60,61]. In western Colorado, Gardner's saltbush-Greene rabbitbrush/charming woodyaster-saline wildrye communities occur in silty-clay, saline soils derived from shale parent materials [101], and James' galleta-Gardner's saltbush-shadscale saltbush-Greene rabbitbrush communities occur in mixed sand-silty-clay soils [101].

Gardner's saltbush grows at midelevations, most commonly in basins and on flat to gentle slopes. It occurs from 1,400 to 2,300 m elevation across its range [31]. Elevation of Gardner's saltbush low scrub [alliances](#) generally ranges from 1,150 to 2,200 m [70]. In Montana and Wyoming, elevation of Gardner's saltbush/Nuttall's povertyweed associations ranges from 1,500 to 1,600 m [88]. For birdfoot sagebrush-Gardner's saltbush dwarf-shrub associations, elevation ranges from 1,250 to 1,525 m [16]. On the northern Colorado Plateau, salt desert shrublands dominated by or including Gardner's saltbush occur on gentle slopes and rolling plains. In Wyoming, eastern Montana, the Dakotas, and adjacent southern Canada, they occur in basins and on mesas, plateaus, plains, low hills, and eroded badlands [70]. Where distributions of Gardner's saltbush, mat saltbush, and basin saltbush overlap in the Northern Great Plains, Gardner's saltbush is generally located on shale outcrops, mat saltbush on alluvial fans, and basin saltbush on eroded slopes [25].

Plant Communities: Gardner's saltbush dominates or codominates many salt desert shrublands, and it is a component of some sagebrush and mixed-grass prairie communities. Salt desert shrublands are generally low in plant species diversity [27,61] and structurally simple, consisting of a shrub layer and a sparse herbaceous layer [61]. When undisturbed, these communities have considerable cover of [biological soil crusts](#) composed of cyanobacteria, algae, and mosses [16]. Allen (1983) provides information on vesicular-arbuscular mycorrhizae (VAM) associations of Gardner's saltbush in a Wyoming salt desert shrubland [1].

Within the Intermountain Region, total vegetation cover in Gardner's saltbush scrub communities ranges from very sparse to moderately dense, and species diversity tends to be low. The shrub canopy is low (<0.3 m tall). These dwarf shrublands often have relatively pure canopies of Gardner's saltbush, although big sagebrush and/or bud sagebrush codominate some stands. Pure Gardner's saltbush stands are common in salt desert shrublands of Montana [88]. Species diversity tends to be lowest when Gardner's saltbush is the only canopy dominant. Other shrubs and half-shrubs that may be present include black greasewood, seepweed, shortspine horsebrush, and winterfat. The herbaceous component is usually sparse except in the Northern Great Plains, where perennial

bunchgrasses may codominate. Common herb associates in this region include alkali sacaton, Indian ricegrass, James' galleta, saline wildrye, western wheatgrass, charming woodyaster, fewflower buckwheat, and Nuttall's povertyweed [25,70].

In the Big Horn Basin and Pryor Mountains of Montana and in Wyoming, the birdfoot sagebrush-Gardner's saltbush dwarf-shrub association typically has a moderately dense canopy (42% mean cover). The herbaceous layer is relatively sparse (<25% mean cover) and dominated by perennial bunchgrasses, with scattered forbs. Bunchgrasses with high consistency include bluebunch wheatgrass, Sandberg bluegrass, and western wheatgrass [70]. In salt desert shrubland of Bighorn Canyon National Recreation Area of Montana and Wyoming, Gardner's saltbush dominates the most arid sites, in shale-derived soils or alluvium. Vegetation cover is low. Gardner's saltbush provides about 12% mean cover, while big sagebrush, bud sagebrush, Indian ricegrass, squirreltail, and plains pricklypear contribute lesser cover [55]. Bud sagebrush may codominant the shrub layer in eastern Montana, and Indian ricegrass, saline wildrye, and/or western wheatgrass may codominate the herbaceous layer [91].

Gardner's saltbush codominates or is a component of some black greasewood-saltbush communities of Colorado, Montana, and Wyoming [20,70]. In central Montana and the western Great Plains, Gardner's saltbush grows on flats dominated by black greasewood, with associated basin big sagebrush, Wyoming big sagebrush, field sagewort, and/or winterfat [69]. It codominates black greasewood-saltbush communities of the Bighorn Basin [55,64]. Gardner's saltbush is a minor component (<1% cover) of black greasewood communities and big sagebrush-rubber rabbitbrush communities of Bighorn Canyon National Recreation Area [55].

Gardner's saltbush is a component of big sagebrush communities [7,19,20]—especially those on clay soils [20] (fig. 3)—and Gardner's saltbush communities often form mosaics with big sagebrush communities. In the Interior Columbia Basin, Gardner's saltbush occurs in xeric Wyoming big sagebrush-winterfat communities, along with sickle saltbush and Sandberg bluegrass [13,19]. In western Colorado, Gardner's saltbush/Indian ricegrass associations intermingle with Wyoming big sagebrush/western wheatgrass associations, with Gardner's saltbush associations occurring on the more saline, clayey soils. Boundaries between the two communities may be abrupt if soils types change abruptly. The Gardner's saltbush community occurs from 1,980 to 2,200 m elevation on flat to gently sloping mesa tops, plateaus, rolling plains, and gentle hills. Soils are very clayey and moderately alkaline (pH 8.0). Shrub cover is very low (6%-8%); herbaceous cover is higher (10%-25%) [7].



Figure 3—Gardner's saltbush (center) in a Wyoming big sagebrush-Gardner's saltbush community on clay flats near the Big Lost River,

Idaho. Image by Matt Lavin from Bozeman, Montana, USA. Used with permission.

Gardner's saltbush codominates or is a component of some mixed-grass prairies [105]. In Wyoming, it codominates in birdfoot sagebrush-Gardner's saltbush/bluebunch wheatgrass-Idaho fescue/phlox mixed-grass prairie [17]. In eastern Wyoming and Montana and western South Dakota, the Gardner's saltbush/western wheatgrass dwarf shrub-mixed-grass prairie alliance occurs on dry soils [70]. In the Charles M. Russell National Wildlife Refuge of north-central Montana, Gardner's saltbush is a component of bluebunch wheatgrass-western wheatgrass associations on upland benches, small mesas, and upper ridge slopes [19]. In Colorado, it codominates mixed-grass prairie with Indian ricegrass, James' galleta, and/or saline wildrye [6]. Near Green River, the Gardner's saltbush-saline wildrye community has relatively high grass cover (20%-30%) and low shrub cover (4%-6%) [7]. The Gardner's saltbush/saline wildrye alliance of west-central Colorado (Mesa County) occurs on north-facing shale slopes with clay soils. In northwestern Colorado (Moffat County), Gardner's saltbush is scattered in mixed-grass prairie with clay soils. Sites are flat to gently sloping, at 1,890 to 2,135 m elevation [70].

See [table A2](#) for a representative list of plant classifications in which Gardner's saltbush occurs.

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: *Atriplex gardneri*

- [GENERAL BOTANICAL CHARACTERISTICS](#)
- [SEASONAL DEVELOPMENT](#)
- [REGENERATION PROCESSES](#)
- [SUCCESSIONAL STATUS](#)

GENERAL BOTANICAL CHARACTERISTICS

- [Botanical Description](#)
- [Raunkiaer Life Form](#)

Botanical Description: This description covers characteristics that may be relevant to fire ecology and is not meant for identification. Keys for identification are available (e.g., [26,27,31,106]).

Gardner's saltbush has variable form. It is a subshrub or half-shrub [31,91,103], so the root crown is woody while the stems are herbaceous [10,39,106]. Stems are unarmed and typically erect [39] but are sometimes prostrate or ascending [31]. They do not branch [40]. Heavy browsing promotes either a mat form [39] or short plants with rounded crowns [70]. Plants are usually <30.5 cm tall; rounded forms may be three to five times broader than they are tall [60]. Leaves are persistent (evergreen) [10,31].

Gardner's saltbush and other saltbushes have unusual flowers and fruits. Gardner's saltbush is typically [dioecious](#) [31,60], or rarely, [monoecious](#) [31,39,60,61]. Both staminate and pistillate flowers are borne in panicles [10,31]. The female flower lacks both petals and calyx [60,65]; it consists of a naked pistil formed in the axis of two small bracts (bracteoles). The bracts are photosynthetically active, modified leaves that envelop the seeds as the fruit develops. They harden into tough structures that protect the seeds [14,60,65]. The fruit is a [utricule](#) [9,49] ([fig. 1](#)). The bracts have small wings or "teeth" [26,27,31,40]. Seeds are fused within the utricule and are generally inseparable [65].

Gardner's saltbush has a taproot [10,14,30,71], primary woody roots, and shallow fibrous roots [71]. Adventitious roots form where stems contact soil [10,60,71]. Primary roots may spread >2 m from the root

crown [71].

Raunkiaer (1934) Life Form:

[Phanerophyte](#)

[Chamaephyte](#) [82]

SEASONAL DEVELOPMENT

Gardner's saltbush is a warm-season (C₄) plant [47,50]. It flowers from spring through fall [10,31,60], generally from mid-May to early July and then intermittently following heavy rains. Fruits ripen about 7 weeks after flowering [10,60]. In Utah, seeds mature from 10 September through 1 March [81]. Time of seed dispersal is variable, but dispersal typically begins in late fall and extends through the following April or May [32]. Not all seeds disperse in their first year; undispersed seeds may remain viable on flowerstalks through one or two winters [49,65]. New herbaceous flowerstalks are produced annually by sprouts arising from the woody root crown [10] (see [Vegetative Regeneration](#)).

REGENERATION PROCESSES

- [Vegetative Regeneration](#)
- [Pollination and Breeding System](#)
- [Seed Production](#)
- [Seed Dispersal](#)
- [Seed Banking](#)
- [Germination](#)
- [Seedling Establishment and Plant Growth](#)

Gardner's saltbush reproduces by sprouting ([10], reviews by [66,67]) and from seed [39].

Vegetative Regeneration: Sprouting may be Gardner's saltbush's primary method of regeneration [71]. It sprouts from the root crown ([88], reviews by [66,67]) and roots ([71,88], reviews by [66,67]) after top-kill. Decumbent stems may [layer](#), producing adventitious roots where the stems contact soil [10]. Sprouting from primary and/or adventitious roots can result in Gardner's saltbush spreading in circular patches across the landscape [88]. Sprouting capability can develop early. In the greenhouse, root sprouts developed from 2-year-old plants, with up to 15 sprouts arising up to 1 m from the root crown [71].

Pollination and Breeding System: Wind disperses the pollen of Gardner's saltbush and other saltbushes. Wind dispersal results in cross-pollination among Gardner's saltbush and other saltbush species as well as pollination among Gardner's saltbush individuals [65,88].

Gardner's saltbush is genetically diverse, with high phenotypic plasticity. [Diploids](#) and higher [polyploids](#) (triploids, tetraploids, hexaploids) occur within Gardner's saltbush and its hybrids [31,97]. Gardner's saltbush is most commonly diploid [99], but most hybridization occurs with Gardner's saltbush parents that are tetraploid [88,95]. Diploid individuals tend to grow in low valleys with fine-textured soils, while tetraploid individuals tend to grow on upper slopes with coarser soils [95].

Seed Production: Information on the amount of seed produced by Gardner's saltbush and age at first seed production was lacking in the literature as of 2020.

Seed Dispersal: Seeds are not released from the utricles upon maturation; instead, the entire fruit disperses [14,65]. Most Gardner's saltbush fruits likely fall under or near the parent plant. Browsing animals may disperse seeds through their digestive tracts, although information on this was lacking in the literature as of 2020. The small utricles may play a minor role in dispersal.

Seed Banking: Gardner's saltbush has persistent aerial [32,65] and soil-stored [93] seed banks. It is common to find Gardner's saltbush plants with 1- and 2-year-old fruits that contain viable seeds [32,65]. It is uncertain how long Gardner's saltbush seeds remain viable in the soil, but they likely remain viable for at least several years. Stevens and Monsen (2004) reported Gardner's saltbush seedlings appearing at an undisclosed location "3 to 4 years after disturbance, indicating seeds survive in the soil and may remain viable for a number of years" [93]. Gardner's saltbush seeds have been stored in open warehouses for 5 to 10 years or more with little or no loss of viability [65].

Germination: Gardner's saltbush seeds are dormant upon dispersal [3,4,14]. Saltbushes have high levels of dormancy and complex, multiple mechanisms of dormancy. Their seeds tend to lose dormancy under extended dry conditions [65].

Gardner's saltbush seed shows variable rates of viability. The percentage of filled or viable seed from four collections in the Red Desert of Wyoming ranged from 48% to 64% of total seed collected [5]. Germination rates in the laboratory are reported at 24% [49], 26% [65], and 80% [9], depending upon seed source and treatments.

Scarification, afterripening, and stratification (~6 months, or over winter) enhance germination rates [3,4,5,49,60,77]. In the field, overwintering is needed to break dormancy and facilitate germination of cold desert saltbush species such as Gardner's saltbush [65]. A laboratory study found 86% mean germination of filled Gardner's saltbush seeds treated with scarification, leaching, and 4-week stratification but only 17% mean germination for filled, untreated Gardner's saltbush seeds [5]. Laboratory experiments and field trials in Wyoming found that among scarification, afterripening, stratification, and washing, stratification was the single most important treatment for breaking seed dormancy in Gardner's saltbush [3].

Bracts on the fruits apparently inhibit germination [34], and thickness of the bract walls determines, in part, how difficult it is to break dormancy [65]. At least partial disintegration of the bracts is apparently required for germination [14]. Either scarification, removal of bracts, or removing seeds from the utricle improves germination rates in the laboratory [65,87]. In the field, the bracts may disintegrate over winter, allowing for spring germination. Fungal infection can accelerate bract disintegration [65]. Acid treatment (e.g., animal ingestion and excretion of fruits) may also disintegrate the bracts [14]. Besides inducing physical dormancy, the bracts may also induce chemical dormancy. Leachate from Gardner's saltbush bracts inhibits germination of debracted Gardner's saltbush seeds in the laboratory [5,77]. Upon germination, germinants emerge from the tip of the seed bracts, which is the weakest part of the utricle [65]. Ansley and Abernethy (1984) noted that in cold, windy, arid environments—such as the Red Desert of Wyoming—Gardner's saltbush seeds are likely exposed to most or all treatments (i.e., scarification and stratification) that help break dormancy [3].

Seedling Establishment and Plant Growth: Gardner's saltbush has variable but often low rates of establishment [14]. Horton (1989) noted that germination was often erratic for Gardner's saltbush seeds planted in Utah, but fall-planted seeds usually established "satisfactorily" [42]. In a Wyoming field study comparing mesic, intermediate, and xeric sites, emergence (percentage of planted viable seeds) of stratified Gardner's saltbush seeds was generally highest on the mesic site with relatively moist, shallow soil. The highest average rate of emergence among all sites was 17.5%. This occurred on the mesic site, at a planting depth of 1 cm. The highest rate of emergence on the xeric site averaged only 1.15%, at a planting depth of 3 cm [4].

Gardner's saltbush seedlings are most competitive on saline soils. During a period of [shrub die-off](#) in northern Utah, presence of Gardner's saltbush seedlings was positively correlated with soil salinity ($r = 0.42$, $P < 0.05$). Researchers speculated that elevated soil salinity suppressed establishment and growth of nonnative invasive annuals, including burningbush and cheatgrass, but not Gardner's saltbush [28].

Growth rate of Gardner's saltbush is variable, probably depending upon environmental conditions. Gardner's saltbush has been described as "very slow-growing" [70], having a "moderate" [60,93] or "adequate" [60] growth rate, and a growth rate at which "plants establish and grow quite rapidly" [42]. An 8-year study in

northern Utah found that annual aboveground production of Gardner's saltbush was positively associated with spring precipitation ($P < 0.05$) [29].

SUCCESSIONAL STATUS

Gardner's saltbush occurs in all stages of succession [93]. It may replace less drought- and salt-tolerant species during times of [shrub die-off](#). In northern Utah, cover of Gardner's saltbush increased while that of shadscale, burningbush, and cheatgrass decreased over a 3-year period of die-off [28]. However, halogeton may displace Gardner's saltbush under some conditions [36,76,86] (see [Other Management Considerations](#)).

Allen (1989) provides information on succession of native VAM in disturbed Gardner's saltbush communities [2].

FIRE EFFECTS AND MANAGEMENT

SPECIES: [Atriplex gardneri](#)

- [FIRE EFFECTS](#)
- [FUELS AND FIRE REGIMES](#)
- [FIRE MANAGEMENT CONSIDERATIONS](#)

FIRE EFFECTS

- [Immediate Fire Effects on Plant](#)
- [Postfire Regeneration Strategy](#)
- [Fire Adaptations and Plant Response to Fire](#)

Immediate Fire Effects on Plant: Fire top-kills Gardner's saltbush [66,67,71,111]. Since Gardner's saltbush is relatively inflammable (see [Fuels](#)), top-kill may result from stem scorching rather than stem ignition.

Postfire Regeneration Strategy:

Prostrate half-shrub, stem growing in organic or mineral soil

[Chamaephytic root crown](#) in organic soil, mineral soil, or on soil surface

[Geophyte](#), growing points deep in soil

[Ground residual colonizer](#) (on site, initial community)

[Initial off-site colonizer](#) (off site, initial community)

[Secondary colonizer](#) (on- or off-site seed sources) [94]

Fire Adaptations and Plant Response to Fire: Gardner's saltbush sprouts from the root crown ([88], reviews by [66,67]) and roots ([71,88], reviews by [66,67]) after top-kill by fire [71,111]. However, information about degree of postfire sprouting was not available in the literature as of 2020. For example, there were no studies that assessed the effects of fire severity or plant age on postfire sprouting.

Gardner's saltbush also establishes from seed after fire [93].

Information on Gardner's saltbush response to fire was anecdotal as of 2020, likely because Gardner's saltbush often grows in places that rarely burn. Nord (1969) reported that Gardner's saltbush recovered quickly along railroad rights-of-way after multiple fires set to reduce cover of nonnative, invasive annuals [71]. Roberts (1994) noted presence of Gardner's saltbush, shadscale, and winterfat "in some areas where we thought they had been eliminated" by cheatgrass-fueled fires in Utah, but no further details were provided [83]. West (1994) observed Gardner's saltbush sprouted after fire in salt desert shrublands in northwestern Utah [111].

FUELS AND FIRE REGIMES

Fuels: Gardner's saltbush is less flammable [63,78,79] and more slow-burning [63,72] than many other desert shrub species due to high concentrations of ash [78,79,85] and sodium and potassium salts in the foliage and stems [78,79]. A laboratory study found heat value of its foliage averaged 45 kw/kg; among 11 shrub species tested, only valley saltbush had a lower mean heat value [63]. Another study found incinerated foliage of Gardner's saltbush had the highest ash content (27%), the highest rate of organic residue (56%), and the lowest percent volatilization (55%) among 16 taxa tested [78,85]. Due to its relative inflammability, Gardner's saltbush is planted in fuelbreaks and sagebrush communities to stop or slow fire spread [37,71].

Although vegetation cover in Gardner's saltbush communities ranges from very sparse to moderately dense [70], most Gardner's saltbush salt desert shrublands have insufficient fuels to carry fire. Vegetation is generally sparse, with barren soil surfaces. For example, in the Badger Wash Basin in Colorado, the soil surface of Gardner's saltbush alliances has 74% bare ground and 6% litter [70].

Fire Regimes: Gardner's saltbush communities have very infrequent, stand-replacement fires. LANDFIRE (2009) models predict fire intervals of about 600 [57,102] to over 1,000 years [58,102].

These FEIS publications provide further information about fire regimes of plant communities in which Gardner's saltbush occurs:

- [Fire regimes of saltbush shrubland communities](#)
- [Fire regimes of mixed dwarf sagebrush communities](#)
- [Fire regimes of Wyoming big sagebrush and basin big sagebrush communities](#)
- [Fire regimes of Columbia Plateau grasslands and steppe communities](#)
- [Fire regimes of Great Basin desert grassland communities](#)

FIRE MANAGEMENT CONSIDERATIONS

Although Gardner's saltbush salt desert shrublands appear resilient to postfire establishment and spread of cheatgrass and other invasive annual grasses due to saline soils [28], other communities with Gardner's saltbush may experience such postfire invasion [21,38,76]. Xeric Wyoming big sagebrush-winterfat communities with Gardner's saltbush are vulnerable to cheatgrass spread after fire [13]. Cheatgrass-fueled fires have spread into mixed desert-shrub communities with Gardner's saltbush in northern Utah [83,111], and Japanese brome has been noted in black greasewood-thickspike wheatgrass communities with Gardner's saltbush in the Charles M. Russell National Wildlife Refuge. In the Alkali Creek area, the authors noted that the black greasewood-thickspike wheatgrass association had "some of the highest cover" of Japanese brome in both burned and unburned sites, but Japanese brome cover appeared highest on burned sites. Higher visual cover of Japanese brome was also noted in bluebunch wheatgrass-western wheatgrass associations on burned sites compared to unburned sites, although the differences were not quantified [19].

MANAGEMENT CONSIDERATIONS

SPECIES: *Atriplex gardneri*

- [FEDERAL LEGAL STATUS](#)
- [OTHER STATUS](#)
- [IMPORTANCE TO WILDLIFE AND LIVESTOCK](#)
- [VALUE FOR RESTORATION OF DISTURBED SITES](#)
- [OTHER USES](#)
- [OTHER MANAGEMENT CONSIDERATIONS](#)

FEDERAL LEGAL STATUS

None [104]

OTHER STATUS

NatureServe (2020) rates Gardner's saltbush as globally secure (G5) [70]. Two closely related species that were once classified as Gardner's saltbush have protection status (Bonneville saltbush and Welsh's saltbush).

Information on state- and province-level protection status of plants in the United States and Canada is available at [NatureServe](#).

Several Gardner's saltbush alliances in the Northern Great Plains have protection status (table 1).

Table 1—Ranking of Gardner's saltbush alliances in the northwestern Great Plains [70].

Alliance	Rank	Distribution
Gardner's saltbush/Nuttall's povertyweed	Vulnerable (G3)	northeastern Montana and possibly northwestern Wyoming
Gardner's saltbush/western wheatgrass	Vulnerable (G3)	broadly distributed
Gardner's saltbush/Indian ricegrass	Vulnerable (G3)	broadly distributed
birdfoot sagebrush-Gardner's saltbush	Vulnerable (G3)	broadly distributed
Gardner's saltbush-bud sagebrush	Imperiled (G2)	eastern Montana and Wyoming
Gardner's saltbush/saline wildrye	Imperiled (G2)	south-central Wyoming and northwestern and west-central Colorado

IMPORTANCE TO WILDLIFE AND LIVESTOCK

Gardner's saltbush provides important year-round browse for wildlife and livestock [42,60]. It is especially valuable winter forage for wild ungulates and livestock ([8,10,30], Banerjee et. al 1999, cited in [89]) due to its persistent leaves [8]. It is a staple food for pronghorn [11,61]; mule deer, lagomorphs, and mourning doves also browse Gardner's saltbush [8,61]. It is a larval food of the common sootywing (*Pholisora catullus*) butterfly and the alfalfa looper (*Autographa californica*) moth [15].

Salt desert shrublands provide habitat for a wide range of wildlife species including arthropods, small birds and mammals, and large ungulates. Although plant diversity is generally low in salt desert shrublands, animal diversity is often high [61].

Palatability and Nutritional Value: Gardner's saltbush is palatable to wild ungulates and livestock [23,71,88]. It is especially palatable to domestic sheep [39,43]. The persistent foliage remains succulent even during hot, dry summer months [12,68].

Gardner's saltbush is nutritious browse that is high in mineral content [78]. It is rated fair in energy and protein values [23]. See these sources for further information on the nutritional value of Gardner's saltbush: [23,78].

Cover Value: Gardner's saltbush provides cover for small nongame birds, upland game birds, and small mammals [23] in arid, saline environments where cover may otherwise be sparse [71]. In the Big Horn, Great Divide, and Washakie basins of Wyoming, mountain plovers used plateaus on black greasewood-shadscale saltbush-Gardner's saltbush salt desert shrublands for nesting [80]. In northwestern Wyoming, black-tailed prairie dogs used Gardner's saltbush-Indian ricegrass-prairie Junegrass mixed-grass prairies more than expected

based on availability. Although that community occurred in a matrix with big sagebrush and black greasewood communities, black-tailed prairie dogs preferentially selected Gardner's saltbush-mixed-grass prairie communities with shrub heights from 8 to 92 cm for colony sites [18]. In south-central Wyoming, the critically imperiled [70] Wyoming pocket gopher habituated only Gardner's saltbush-dominated salt shrubland with fine-textured soils and flat topography, while the more common northern pocket gopher habituated more productive, adjacent big sagebrush shrubland with coarser soils [53].

VALUE FOR RESTORATION OF DISTURBED SITES

Gardner's saltbush provides soil stabilization [10,93] and is used in restoration plantings on semiarid and arid lands [14,93] including mine spoils [60,75,90,112], oil fields [46], and rangelands [60]. It is favored for restoration plantings due to its palatability and tolerance to drought, saline soils, and alkaline soils ([14], Banerjee et. al 1999, cited in [89]). It is planted on windbreaks in northern mixed-grass prairie communities (Banerjee et. al 1999, cited in [89]). Because Gardner's saltbush is relatively inflammable, it is also planted to stop or slow fire spread [37,71] (see [Fuels](#)).

Artificial regeneration of Gardner's saltbush can have mixed success, with potentially low and/or variable rates of establishment on arid sites [14,22,41,48]. It has sometimes been established by direct seeding (e.g., drilling) [10,37,60,74,93] or container plantings [35,93]. Best success is achieved on mixed-shrub sites or sites that receive at least intermittent summer rains [93]. See these sources for information on Gardner's saltbush propagation: [9,42,49,73,93,100]. Cultivars of Gardner's saltbush were not available as of 2020 [103].

Management that promotes VAM favors Gardner's saltbush establishment and growth on disturbed sites [2,112]. Allen (1989) provides information on inoculating native VAM into soils of disturbed Gardner's saltbush communities [2].

OTHER USES

Gardner's saltbush is planted as a native ornamental [15].

OTHER MANAGEMENT CONSIDERATIONS

Rangelands: Gardner's saltbush is fairly resistant to browsing pressure; however, its cover and frequency are reduced in areas with heavy or continuous browsing pressure. It tolerates light to moderate use [10,30]. In salt desert shrubland of Wyoming, for example, Gardner's saltbush (misclassified as Nuttall's saltbush) tolerated up to 30% winter utilization by domestic sheep without substantial loss of canopy cover [30]. In the Red Desert of Wyoming, it averaged 16% frequency on two relict buttes that are inaccessible to wild and domestic ungulates and 4% frequency on accessible areas [59]. In a 10-year study in western Colorado, shrub cover on Gardner's saltbush-Greene rabbitbrush/charming woodyaster-saline wildrye and James' galleta-Gardner's saltbush-shadscale saltbush-Greene rabbitbrush rangelands declined 32% on transects grazed by cattle and domestic sheep from November to mid-May and by 8% on transects in livestock exclosures. Stocking was reported as "rather heavy". Gardner's saltbush frequency in the first community averaged 75% and 88% on grazed and ungrazed plots, respectively, and 32% and 34%, respectively, in the second community. Overall mean survivorship of Gardner's saltbush was 62% and 82% on grazed and ungrazed plots, respectively [101]. With moderate grazing, livestock utilization of 30% [44] to 40% [43] has been reported for Gardner's saltbush.

Some low cold-desert salt shrublands have become badly degraded by overgrazing. Clary and Holmgren (1987) noted that on rangelands of eastern Montana, eastern Wyoming, and Colorado, 30 years of unregulated livestock grazing in the early 20th century resulted in desertification of some areas [16]. Such sites are difficult to revegetate [42]. The "imperiled" status of Gardner's saltbush/saline wildrye alliances is based on the assumption that grazing has caused a decline in the condition of many of these alliances [70].

The good [rangeland condition](#) of some Gardner's saltbush sites is due in part to their inaccessibility. NatureServe (2020) concluded that that for the Gardner's saltbush/Nuttall's povertyweed association, the "only remotely possible disturbance to this association is (off-) roading", but because these sites are "impassible with even minor precipitation events" (due to high clay content), they are often "bypassed" by off-road vehicle recreationists [70].

Shrub die-off: Cold deserts are subject to periodic shrub die-offs. Causes of the die-offs are varied and likely interactive; they have been attributed to weather extremes and/or climate change (e.g., waterlogging caused by above-average precipitation, extended cold winter temperatures with long-lasting snow cover, and severe summer drought), increased salinity in soils, fungal infections, and overgrazing [28]. Stutz (1978) noted that after the 1976-1977 winter drought in Wyoming, most surviving Gardner's saltbush individuals were tetraploid. Diploid individuals were "almost completely wiped out" [95]. Gardner's saltbush may replace less drought- and salt-tolerant species during periods of shrub die-offs [28] (see [Seedling Establishment and Plant Growth](#)).

Climate change and possible changes in plant community composition: Padgett (2018) postulated that salt desert shrublands have moderate to high vulnerability to climate change [76]. Climate change is expected to result in more extreme precipitation events in salt desert shrublands [76,111]. This may increase incidences of shrub die-off.

Halogeton (an invasive annual forb) may replace Gardner's saltbush in some salt desert shrublands [36,76,86], especially during periods of shrub die-back. Livestock grazing may exacerbate this replacement [36]. Near Green River, Colorado, cattle overgrazing in a Gardner's saltbush/Indian ricegrass community greatly reduced graminoid cover and promoted establishment and spread of halogeton [7]. A laboratory study found Gardner's saltbush and halogeton were about equally salt tolerant, leading the researchers to conclude that another, unknown mechanism is responsible for displacement of Gardner's saltbush by halogeton in saline soils [86].

Conversely, increasing aridity may result in Gardner's saltbush displacing relatively mesic species on some sites. Romme and Turner (1991) postulated that with global warming, Gardner's saltbush-black greasewood desert shrubland may replace sagebrush shrubland on warm, dry, low-elevation sites in the Greater Yellowstone Ecosystem [84].

APPENDIX

SPECIES: [Atriplex gardneri](#)

- [Table A1: Plant names](#) [Table](#)
- [A2: Plant communities](#)

Table A1—Common and scientific names of plants mentioned in this review. Links go to other FEIS Species Reviews.	
Common name	Scientific name
Cacti	
plains pricklypear	Opuntia polyacantha
Forbs	
burningbush	Bassia scoparia
charming woodyaster	Xylorhiza venusta
fewflower buckwheat	Eriogonum pauciflorum
field sagewort	Artemisia campestris
halogeton	Halogeton glomeratus
Nuttall's povertyweed	Monolepis nuttalliana
phlox	Phlox spp.
Graminoids	
alkali sacaton	Sporobolus airoides

bluebunch wheatgrass	<i>Pseudoroegneria spicata</i>
blue grama	<i>Bouteloua gracilis</i>
cheatgrass	<i>Bromus tectorum</i>
Idaho fescue	<i>Festuca idahoensis</i>
Indian ricegrass	<i>Achnatherum hymenoides</i>
James' galleta	<i>Pleuraphis jamesii</i>
Japanese brome	<i>Bromus japonicus</i>
prairie Junegrass	<i>Koeleria macrantha</i>
saline wildrye	<i>Leymus salinus</i>
Sandberg bluegrass	<i>Poa secunda</i>
squirreltail	<i>Elymus elymoides</i>
thickspike wheatgrass	<i>Elymus lanceolatus</i>
western wheatgrass	<i>Pascopyrum smithii</i>
Shrubs	
basin saltbush	<i>Atriplex tridentata</i>
big sagebrush basin big sagebrush Wyoming big sagebrush	<i>Artemisia tridentata</i> <i>Artemisia tridentata</i> subsp. <i>tridentata</i> <i>Artemisia tridentata</i> subsp. <i>wyomingensis</i>
birdfoot sagebrush	<i>Artemisia pedatifida</i>
Bonneville saltbush	<i>Atriplex bonnevillensis</i>
black greasewood	<i>Sarcobatus vermiculatus</i>
bud sagebrush	<i>Picrothamnus desertorum</i>
fourwing saltbush	<i>Atriplex canescens</i>
Gardner's saltbush	<i>Atriplex gardneri</i>
Greene rabbitbrush	<i>Chrysothamnus greenei</i>
iodinebush	<i>Allenrolfea occidentalis</i>
mat saltbush	<i>Atriplex corrugata</i>
moundscale	<i>Atriplex</i> × <i>aptera</i>
Nuttall's saltbush	<i>Atriplex nuttallii</i>
robust saltbush	<i>Atriplex robusta</i>
rubber rabbitbrush	<i>Ericameria nauseosa</i>
sagebrush	<i>Artemisia</i> spp.
saltbush	<i>Atriplex</i> spp.
shadscale saltbush	<i>Atriplex confertifolia</i>
shortspine horsebrush	<i>Tetradymia spinosa</i>
seepweed	<i>Suaeda</i> spp.
sickle saltbush	<i>Atriplex falcata</i>
valley saltbush	<i>Atriplex cuneata</i>
Welsh's saltbush	<i>Atriplex welshii</i>
winterfat	<i>Krascheninnikovia lanata</i>

Table A2—Representative plant community classifications in which Gardner's saltbush occurs.

FRES Ecosystems

FRES29 Sagebrush

FRES30 Desert shrub

FRES38 Plains grasslands [33]

Kuchler Plant Associations

K038 Great Basin sagebrush

K040 Saltbush-greasewood

K055 Sagebrush steppe

K057 Galleta-three-awn shrubsteppe

K064 Grama-needlegrass-wheatgrass

K066 Wheatgrass-needlegrass [56]

SRM (Rangeland) Cover Types

SRM 310 Needle-and-thread-blue grama

SRM 402 Mountain big sagebrush

SRM 403 Wyoming big sagebrush

SRM 406 Low sagebrush

SRM 408 Other sagebrush types

SRM 414 Salt desert shrub

SRM 606 Wheatgrass-bluestem-needlegrass

SRM 607 Wheatgrass-needlegrass

SRM 608 Wheatgrass-grama-needlegrass

SRM 609 Wheatgrass-grama

SRM 610 Wheatgrass [92]

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