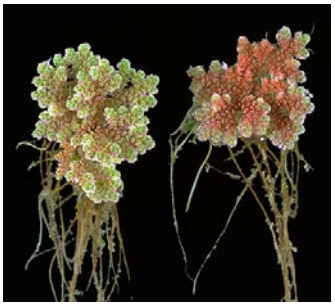
Azolla spp.

Mosquitoferns

Family: Azollaceae
Range: Throughout most of the western United States, except Idaho, Wyoming, Montana and North Dakota.
Habitat: On still water or mud in ponds, small lakes, slow-moving streams and channels, ditches, rice fields, and sloughs. Often grow in eutrophic water. Do not tolerate saline water.



Origin: Native to the United States, including the western states. Mosquitoferns are sometimes sold as aquarium or pond ornamentals. In East Asia, mosquitofern is used as livestock feed and as a nitrogen source in rice fields.
Impacts: Native mosquitoferns are consumed by wildlife, especially waterfowl, and are usually a desirable component of natural aquatic communities. In addition, they provides breeding habitat for aquatic insects important to fisheries. In some human use areas, dense colonies can become a nuisance in certain situations by excluding other aquatic vegetation, encouraging the growth of algae, interfering with livestock drinking, and clogging water pumps.
Western states listed as Noxious Weed: Pinnate mosquitofern (*A. pinnata* R.Br.) is listed as a Federal Noxious Weed, but is not naturalized in the United States, although it may be cultivated as an aquarium plant. It is also a state listed Noxious Weed in California and Oregon

Mosquitofern species are small, annual to perennial, free-floating aquatic ferns that often occur in colonies. Pacific mosquitofern (*A. filiculoides* Lam.) and Mexican mosquitofern (*A. mexicana* C. Presl) are native species that occur in many western states. Upper leaf lobes are typically colonized by the nitrogen-fixing cyanobacterium *Anabaena azollae*. Stems are floating and are pinnately branched with roots suspended in the water column. Young plants are gray to green but turn red to brown with age and season.

Plants produce spores that disperse with wind, but the most common mechanism of dispersal is vegetative, with plant fragments moving in water or clinging to the feet or feathers of birds. Careless disposal of pond or aquarium contents can introduce plants to previously uninhabited areas. Colonies typically enlarge rapidly during the warmer months and diminish during the cool months.

NON-CHEMICAL CONTROL

Mechanical (floating booms, suction devices)	Small infestations of the weed in accessible areas may be removed using rakes and fine meshed nets. The disadvantage of mechanical control, however, is that under ideal conditions, the weed can double itself every 4 to 5 days. Thus, it must be repeated often. For small infestations (1 to 2 acres), floating booms can be dragged (preferably "down wind") from the shore or pushed by boats to consolidate mats of *Azolla* which can then be removed with rakes. *Azolla* provides good composting material. In large lakes, mechanical harvesters equipped with surface "skimmers" or surface suction devices can remove mats.
Cultural	The use of water-circulation devices can sometimes reduce accumulation of large biomass. Reducing nutrient inputs can also be helpful (e.g. divert runoff from turf or other areas that provide nutrients).
Biological	A native frond-feeding weevil, *Stenopelmus rufinasus*, has been used for control of *Azolla filiculoides* with some success outside the United States. Early research on the flea beetle *Pseudolampsis guttata* suggests

	it may also be useful. The triploid (sterile) grass carp (white amur) is a relatively nonselective herbivorous fish that will consume *Azolla* and other small floating plants (e.g. duckweeds). The fish do not selectively feed on "non-native" plants so careful monitoring of feeding impacts is necessary. In some Asian crop systems, use of fish and ducks are integrated to provide control of *Azolla* in rice production.

CHEMICAL CONTROL

The following specific use information is based on reports by researchers and land managers. Other trade names may be available, and other compounds also are labeled for this weed. Directions for use may vary between brands; see label before use. Herbicides are listed by mode of action and then alphabetically. The order of herbicide listing is not reflective of the order of efficacy or preference.

AROMATIC AMINO ACID INHIBITORS	
Glyphosate *Rodeo*, *Aquamaster*	**Rate:** Spot treatment: 2% v/v solution (*Rodeo* or *Aquamaster*) for foliar spray with approved aquatic surfactant (0.5%) **Timing:** Postemergence to foliage from spring to mid-summer. **Remarks:** Glyphosate is a slow-acting, systemic herbicide. *Azolla* often forms thick mats that can prevent glyphosate (or other foliar-applied herbicides) from penetrating the canopy and therefore unexposed fronds will reestablish the population.
BRANCHED-CHAIN AMINO ACID INHIBITORS	
Bispyribac-sodium *Tradewind*	**Rate:** 8 oz product/acre (6.4 oz a.i./acre). Allow 30 days between applications and apply up to four times per year. **Timing:** Postemergence to foliage from spring to mid-summer. **Remarks:** Bispyribac-sodium is a slow-acting herbicide and may take 4 to 6 weeks to show effects.
Imazamox *Clearcast*	**Rate:** Spot treatment: 2% v/v solution as a foliar spray plus 1% methylated seed oil (MSO) **Timing:** Postemergence to foliate from spring to mid-summer. **Remarks:** Use an approved surfactant.
Penoxsulam *Galleon*	**Rate:** 5.6 to 11.2 oz product/acre (1.4 to 2.8 oz a.i./acre), but most often used at 8 oz product/acre (2 oz a.i./acre). Apply in 20 to 100 gal spray solution/acre. **Timing:** Postemergence to foliage from spring to mid-summer. **Remarks:** Penoxsulam is a slow-acting herbicide and may take 4 to 6 weeks to show effects.
PIGMENT SYNTHESIS INHIBITORS	
Fluridone *Sonar*	**Rate:** For in-water treatment: 10 to 30 ppb **Timing:** Apply directly to water from spring to mid-summer (before large biomass has developed). **Remarks:** Fluridone is a slow-acting herbicide that may take several weeks to show effects.
CONTACT PHOTOSYNTHETIC INHIBITORS	
Diquat *Reward*, *Redwing*	**Rate:** 2 to 4 pt product/surface acre (0.5 to 1 lb a.i./surface acre) **Timing:** Postemergence to foliage from spring to mid-summer. **Remarks:** Diquat is a fast-acting contact herbicide. Repeated applications may be needed. *Azolla* often forms thick mats that can prevent diquat (or other foliar-applied herbicides) from penetrating the canopy and therefore unexposed fronds will reestablish the population.
Flumioxazin *Clipper*	**Rate:** For in-water treatments: 100 to 400 ppb **Timing:** Apply directly to water from early spring to early summer, during the plant's rapid growth phase. **Remarks:** Flumioxazin is rapidly degraded and is inactive if pH exceeds 8.5. Thus, it is important to only use if pH will not exceed 8.5. It is best to apply flumioxazin in the early morning when the pH is low.

RECOMMENDED CITATION: DiTomaso, J.M., G.B. Kyser et al. 2013. *Weed Control in Natural Areas in the Western United States*. Weed Research and Information Center, University of California. 544 pp.