Exotics in the Southern California Vernal Pool Ecosystem

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Vernal pools are small, temporary ponds that fill are filled by winter rains and dry up by late spring. Often the ponds are well defined, sometimes functioning more or less independently, but usually they are interconnected by shallow drainages, especially in rainy years. In some cases the entire habitat consists of drainages and swales with the pool or pond component less noticeable. Occasionally the ponds are large enough to be considered vernal lakes, the center of which may actually hold water year around or at least long enough for a fresh water marsh to develop. Pools form in flat or gently sloping landscapes over an impervious soil layer, usually clay, which can be underlain by basalt, granitic rocks or a hardpan formed of clays or cobbles cemented together. In San Diego County, the majority of the pools, have in addition to clay surface soils, a hardpan layer beneath them made up of cobbles held together by a combination of iron and silica.

Pool species of uncertain origin

Although temporary pools or ponds are found in many places in the world, those in the California floristic province (southwestern Oregon, cismontane California and northern Baja California, Mexico) contain a unique flora and fauna with many endemic species, even endemic genera. Notable among these are the Orcutt grasses, the mint genus *Pogogyne,* which has two narrow endemic species in San Diego County, and various species of invertebrates such as the two fairy shrimp, *Streptocephalus wootoni* and *Branchinecta sandiegonensis,* which are restricted to southern California. The endemic plant species have been fairly well studied and much work is currently being done on the aquatic invertebrates.

Many of the exotic plant species found in and around vernal pools have, likewise, been well studied because they are widespread in such habitats as grazing and pasture lands and to a lesser extent artificial impoundments. Examples include the brome grasses (*Bromus* spp.), oats (*Avena* spp.), thistles (*Centaurea* spp. and others), cat's ear (*Hypochoeris glabra*), mustards (*Brassica* spp.) and filarees (*Erodium* spp.).

A third category of pool species exists which has been little discussed. These are plants that are not demonstrably native or introduced. James Carlton (1996) calls them cryptogenic species from the Greek words kryptos, meaning hidden and genes, meaning born. A tip-off that we are discussing such a species is the word "cosmopolitan" which is frequently used for widespread species of uncertain origin. Wetland plants often fit this description because they are widely dispersed by animals, wind and water currents and human activities.

Vernal pools contain a number of these cosmopolitan species (Thorne 1984). Common ones in San Diego County are chaffweed (*Centunculus mininuts*), toad rush (*Juncus bufonius*), grass poly (*Lythrum hyssopifolia*) and mouse-tail (*Myosurus minimus*). Their classification as native, introduced or cryptogenic is not a minor matter. If native, their presence is an important vernal pool indicator, part of the pool's biodiversity, and an integral component of species interactions in the ecosystem of the pool and its adjacent habitat. If introduced, they may adversely impact desirable endemic species, reduce the pools' priority for preservation or management of the habitat or be the target of management efforts aimed at removal or control.

Grass poly (*Lythrum hyssopifolia*) is a good example to illustrate the importance of correct classification as to native, introduced or cryptogenic. Jepson (1925), Munz and Keck (1968) and Munz (1974) indicated a wide distribution for *Lythrum,* including Europe and other continents, but they did not comment on whether it was native or introduced to North America or more specifically, to California. Peck (194 1), in an Oregon flora, and more recently Hickman's (1993) revised Jepson Manual declare the species to be an introduced European native. Herbarium records suggest that it was introduced on the East Coast early in the 19th century and to California near the end of the century (Shinners 1953).

I have been examining floras of Europe and other areas for references to *Lythrum hyssopifolia*. It is mentioned as present in England and southern France at the end of the 19th century (Flahault 1893, Purchas and Ley 1889). Sir

Edward Salisbury, former director of the Kew Gardens in England, stated that in modem times the plant was occasionally introduced with seed, but he thought it may have been more widely distributed in England prior to the extensive conversion of wetlands (Salisbury 1968, 1971). He bases this on its presence in Bronze Age soil deposits and the fact that it has a common name, what he calls a "folk name" - grass poly. Salisbury places *Lythrum* in a class of plants he calls the "pioneer flora of exposed mud" (Salisbury 1971). All of the 50 species he examined are widely distributed in intermittently exposed soils of freshwater habitats. He concluded that these pioneering plants, like much of the endemic vernal pool flora we are familiar with, had diverse origins in many plant families. What they share is the affinity for temporary wetland habitats. Why these plants are so widespread is unknown, but they may tolerate a wider range of conditions than many of our endemic plants, be more easily dispersed, depend less on pollinators for reproduction and respond favorably to disturbance that opens up habitat. In any case, it appears that *Lythrum* has been introduced to California within the last century and that it has a weedy growth habit. Human activities may tip the balance in its favor as they do with many other weedy plants. High abundance of *Lythrum* may be an indicator of excessive disturbance that needs to be dealt with. For restoration projects, this suggests managing for a low abundance of *Lythrum* until other, more sensitive species are established.

Vernal pool exotics

Exotic plants found in vernal pools can be divided into three groups based on their adaptability to different moisture regimes. Group One contains upland plants with limited or no inundation tolerance. Examples are the brome grasses (*Bromus* spp.), cat's ear (*Hypochoeris glabra*) and filarees (*Erodium* spp.). Group Two consists of plants with inundation tolerance comparable to most pool species. This group includes brass buttons (*Cotula coronopifolia*), Pacific bent grass (*Agrostis avenacea*), rabbit's foot grass or annual beard grass (*Polypogon monspeliensis*), and perennial rye grass (*Lolium perenne*). Group Three includes aquatic or freshwater marsh species that not only tolerate but require long periods of saturated soil or inundation. These range from escaped cultivars such as umbrella plant (*Cyperus involucratus*), to cattails (*Typha* spp.) and Cape-pondweed (*Aponogeton distachyon*).

At the edges of pools, just above or below the elevation of maximum water level, the number of exotic species is high and they can be very dense. Vegetation data from permanent transects indicate that the occurrence of exotic upland species declines sharply with increasing duration of inundation (Bauder 1987). Controlled experiments confirm the intolerance of some exotic grassland species to an inundation period greater than 2 weeks (Bauder 1987). If the normal hydrology of the pool is undisturbed, natural processes can thus reduce the abundance and number of upland exotics in vernal pool basins. The intolerance of many grassland exotics for the moderately long inundation periods characteristic of pools has undoubtedly helped to maintain a high proportion of natives in pool basins.

One endemic pool plant, mesa mint (*Pogogyne abramsii*) is apparently quite sensitive to high densities of either itself or other species, both upland species and those that tolerate inundation. Its distribution in the field may be reduced by competition with upland weeds where water doesn't stand long enough to kill the weeds (Bauder 1987). Within pool basins its abundance may be reduced by competition with species in Group Two, such as *Cotula* and *Polypogon* (Bauder, unpub. data). Comparison of *Pogopne's* growth in pots under controlled conditions and its distribution in the field supports the conclusions regarding upland weeds. Experimental manipulation of density indicates that survivorship and biomass of *Pogogyne* are reduced at high density (Bauder 1987). Planting at low density or inundating long enough to reduce density by killing plants, increases fitness (survivorship x seed set). Even though *Pogogyne* may prefer soil that is moist but never inundated, competition with upland plants seems to have nudged it further down into the pool where upland plants are excluded and some *Pogogyne* plants die as well.

Presently, I am working on a vernal pool restoration project at Naval Air Station Miramar that was originally funded by the California Department of Fish and Game and then extended by funding from the U.S. Navy. In the summer of 1993, fill was removed from 30 vernal pool basins and used to create artificial Mima mounds (Bauder 1994). The recontoured basins were inoculated with seeds and soil duff salvaged from a nearby vernal pool site lost to development. I have a two-pronged approach to managing exotics in the hopes of maintaining the newly established populations of vernal pool plants. I have planted the artificial mounds with seeds of easily established native shrub species, primarily buckwheat (*Eriogonum fasciculatum*) and goldenbush (*Isocoma menziesii*). The purpose is to reduce the available habitat open to exotic upland weeds. I am also weeding in and near basins. We have used a weed whip to cut back nearly mono-specific stands of *Lolium* just prior to fruiting. Finally, we are attempting to hand weed *Lolium, Cotula* and *Polypogon* from the pool basins. I am monitoring our progress, or lack thereof, with photographs taken at established points, estimates of cover and a dozen permanent vegetation transects.

The third group of plants, like the first, is best controlled by maintaining proper hydrology. The sudden appearance of umbrella plant or cattails usually indicates abnormal inputs of water from culverts, broken irrigation pipes, or some other unnatural runoff.

Ecosystem effects of exotics

Extensive stands of exotics may be altering many of the relationships among animals and the vernal pool biota by providing an abundant food supply for fossorial rodents, ants and rabbits. Fires may now have adverse impacts on pools because of a greater fuel load provided by exotics.

Hunt (1992) examined the feeding preferences of pocket gophers (*Thomomys bottae sanctidiegi*). She analyzed the stomach contents of gophers at a site on NAS Miramar and determined that oats, brome grasses and filaree were a large part of their diet. Pocket gophers and other rodents may have a negative impact on native geophytes associated with vernal pools such as *Brodiaea* spp. and *Muilla* spp.

Rabbits graze in and near pool basins and the disturbed grasslands surrounding vernal pools seem to support a dense population of rabbits, if the quantity of fecal pellets and number of prominent "dust bathing" areas are any indication. Harvester ants (*Pogonomyrmex californicus*) are very active in the vicinity of vernal pools, too. They collect seeds of cat's ear, filaree and *Vulpia myuros,* producing a ring of seeds and chaff around their nests. When the winter rains begin, the rings produce dense stands of upland exotics. Rings can substantially alter the microtopography of pool basins when the nests are constructed there. In a year of low rainfall, the residue of seeds on the ant collection trails may produce a stripe of exotics across numerous pool basins.

Cox and Austin (1990) completed a 2-year study of the impact of fire on vernal pool vegetation on NAS Miramar. It was complicated by the fact that one of the two years was very dry. They found that the cover of upland exotics was significantly reduced in burned pools and the fire had a modest, favorable impact on the vernal pool species. Miramar is currently monitoring pools impacted by an unplanned wildfire (Cobb, pers. comm.).

Conclusions

1. Classification of vernal pool plants and associates into native, exotic and cryptogenic is important for management and preservation decisions.
2. Three groups of exotic plants impact the vernal flora, with upland and marsh plants generally associated with unnatural pool hydrology, although they can have impacts at the upper and lower limits, respectively, of the pool inundation gradient.
3. The exotics that pose the greatest threat to vernal pools are those with habitat preferences and tolerances similar to the native pool flora. No easy techniques for dealing with these species are apparent.
4. Finally, exotics may have less evident, but nonetheless important, impacts on the entire vernal pool ecosystem by promoting population expansion of animals such as pocket gophers, harvester ants and rabbits and creating a greater fuel load for wildland fires.

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