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# On the Perils of Ecological Restoration: Lessons fr om the El Segundo Blue Butterfly

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**Abstract** . Land use planning and permitting in southern California increasingly relies on ecological restoration as mitigation for damage done to natural habitats by development projects. Many restoration attempts fail miserably, for a number of reasons. Three areas of concern for restoration projects are: 1) historical accuracy and completeness, 2) ecotype accuracy, and 3) type conversions. Using evidence from a restoration project for the El Segundo blue butterfly we will show the importance of historical accuracy in ecological restoration. Other examples from the El Segundo dunes will illustrate the vital importance of using local ecotypes in restoration projects. Finally, we will discuss the issues raised by type conversions and other questionable restoration practices, why they are allowed as mitigation, and their effect on regional conservation goals.

**Keywords** : Restoration; mitigation; historical accuracy; ecotype accuracy; type conversion; El Segundo blue butterfly

## Introduction

Ecological restoration is used as a mitigation for damage done to natural habitats and species by development projects. Although such restoration projects take place under the auspices of public agencies such as the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the California Coastal Commission, and the California Department of Fish and Game, they often are plagued by weaknesses that go largely unnoticed or unquestioned by environmental activists, the academic community, politicians, and the agencies themselves. Drawing from experience with a revegetation project for the El Segundo blue butterfly, we explore some of the common pitfalls of restoration projects.

Any discussion of restoration requires an understanding of what is meant by the word. The definition arrived upon by a National Research Council committee was "the return of an ecosystem to a close approximation of its condition prior to disturbance" (NRC 1992). Unfortunately, mitigation almost never has recreation of the historic conditions as its goal, rather, success is defined as establishment of the dominant vegetation in an area (unpublished data and California Ecological Restoration Projects Inventory 1997). If historic conditions are not the goal, as they rarely are, the question arises whether restoration is undertaken to reassemble the species and ecotypes historically present or to use different species that the restorationist believes will serve the same function in the ecosystem. The distinction here is made between a concentration on *diversity* or *function*. Jordan *et al.* (1987) suggest that restorationists can illustrate their understanding of ecosystems by *imitating* rather than *copying* natural systems. They claim that insight from restoration research will be gained from being able to "create communities that resemble other communities in various ways, but that actually *differ* from them in species composition" (Jordan *et al.* 1987: 17). We differ from Jordan *et al.* about the goals of restoration and restoration research. For reasons that will be illustrated below, we believe that restoration should have as its goal the preservation of biodiversity in a system that requires minimal human management and that is historically accurate and historically complete. To qualify as a "restoration" a project should strive to be historically complete and accurate and consider the reintroduction or management of all biodiversity, including insects, mammals, birds, plants, and cryptobiotic crusts. A project that reintroduces the historically present plants is a "revegetation," a project that only establishes the dominant cover is a "partial revegetation," and any project that establishes species not native to the site is an exercise in "landscaping."

A second aspect of the definition of restoration is what has been called "the ecotype question" (Cairns 1987: 316, Kline and Howell 1987: 84). Debate centers around the relative importance of matching local ecotypes when reestablishing plants on a restoration site. Although academic consensus seems to support using local ecotypes (see Millar and Libby 1989, Read *et al.* 1996, Allen 1997), we illustrate the importance of local ecotypes on higher trophic levels and the maintenance of biodiversity. A project that does not use local ecotypes is not a "restoration."

The final facet of restoration that we discuss is whether type conversion — the creation of one natu-

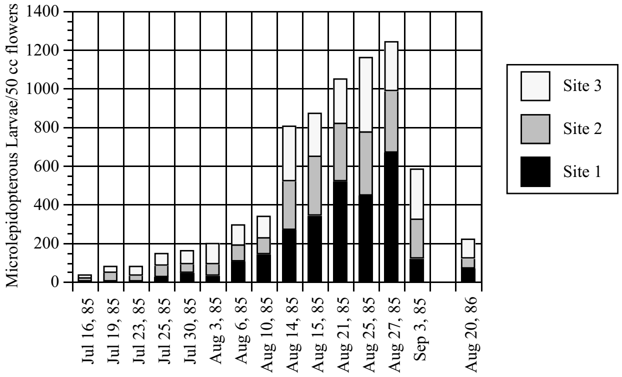


Fig. 1. Abundance of larval microlepidopterous competitors of the ESB (Gelechiidae and Cochylidae) on *Eriogonum parvifolium* at three sites at LAX (Pratt 1987).

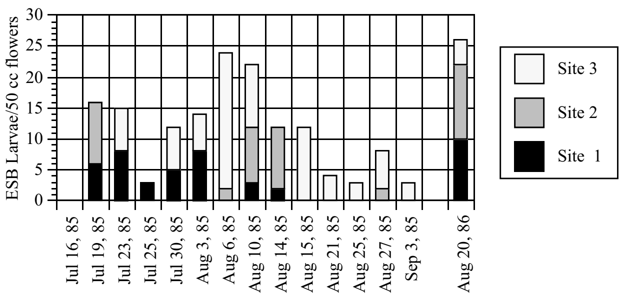


Fig. 2. Abundance of ESB larvae on *Eriogonum parvifolium* at three sites at LAX (Pratt 1987).

ral community in an area that was previously occupied by another natural community — constitutes restoration. Examples of this specific kind of historical inaccuracy abound, especially for wetland and riparian restoration projects (Allen and Feddema 1996). We argue that ecological restoration does not include type conversions.

## Historical Accuracy and Completeness

A story illustrates the dangers of historical inaccuracy. The El Segundo blue butterfly (*Euphilotes bernardino allyni* Shields) (ESB) was distributed historically along the El Segundo dunes from Ballona Creek to the Palos Verdes Peninsula (Mattoni 1992). Its sole foodplant for all life stages is the coastal buckwheat, *Eriogonum parvifolium* Smith. Larvae feed on the flowerheads, pupate directly beneath the plant, and adults perch, mate, usually nectar, lay eggs, and probably die on flowerheads (Mattoni 1992).

The ESB persists in greatest numbers on the dunes at the Los Angeles International Airport (LAX). In 1975 the backdune at LAX was recontoured to realign Pershing Drive. The recontoured backdunes were stabilized with a "natural" seed mix (Mattoni 1989a). Although perhaps well intentioned, the seed mix was representative of coastal sage scrub, not the native dune scrub community. Whether this effort was meant as a restoration is irrelevant, the event of interest is that common buckwheat (*Eriogonum fasciculatum* (Benth.) Torrey & A. Gray) was introduced and established on the dunes.[1]

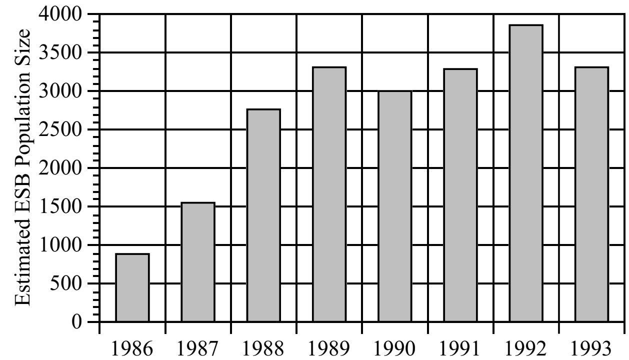


Fig. 3. Recovery of ESB population following removal of *Eriogonum fasciculatum* and provision of more foodplant (Mattoni *et al.,* in prep.).

Numerous other insects exploit *Eriogonum* flowerheads, which results in intense competition for the resource. This guild of competitors includes at least ten species of Lepidoptera in addition to an unknown number of other orders. While the ESB is univoltine (one generation per year) and is specialized for the short, late blooming season of *E. parvifolium*, other competitors are more opportunistic and will utilize multiple hosts. The introduction of the earlier blooming *E. fasciculatum* to the dunes therefore had the result of differentially increasing populations of competitors by providing another food source that the ESB could not exploit. Pratt (1987) showed that there was a doubling of competitive larvae on *E. parvifolium* flowerheads in mid-August, which, considering an average generation time of one month, corresponded with senescence of *E. fasciculatum* in mid-July. Increased concentrations of other larvae correlated with depressed ESB populations. Experiments confirmed that other microlepidopterous larvae outcompete and even cannibalize ESB larvae. In addition, the other moths probably provide a reserve of parasitoids that they share with the ESB (Pratt 1987, Mattoni 1988). The increase in ESB and decrease in other larvae shown in the 1986 follow-up sample is likely the result of intense pruning of *E. fasciculatum* to delay flowering.

Mattoni initiated a revegetation program on the LAX dunes in 1986; one of the first actions was the removal of *E. fasciculatum* (Mattoni 1989b). Recovery

[1] Also present in the seed mix were *Coreopsis gigantea* (Kellogg) H.M. Hall, *Atriplex canescens* (Pursh) Nutt., *Lupinus excubitus* M.E. Jones, *Eriogonum giganteum* S. Watson, *E. cinereum* Benth., and other non-native species. Only *E. fasciculatum* has expanded on the dunes; the others are gradually disappearing.

of the ESB over the course of the revegetation program is estimated by using a model based on transect counts (Mattoni *et al.*, in prep.). Increases in the first two years of the program can largely be attributed to removal of *E. fasciculatum*, because newly established *E. parvifolium* had not yet matured. The resonating effect of *E. fasciculatum* on insect community composition shows the result of introducing just one species that is not native to an area. This observation implies that attention paid to historical distribution of species is a crucial first step to ensure the ecological integrity of restoration projects.

Another implication of this example, gained from recognizing the far-reaching effects of just one species on natural community composition, is that restoration should also strive to be historically complete. Although moths and butterflies are rarely target species for restoration projects, and almost never considered in mitigation design, many depend on a single host plant species. Furthermore, butterflies often depend on the rare species in a community, which are often overlooked in restoration efforts. The notion of the importance of a single species on the ecosystem is not new; Paine's (1969) metaphor of the "keystone species" was intended, in his words, "to convey a sense of nature's dynamic fragility and the unsuspected consequences of removing (or adding) species" (Paine 1995). *Omission of one plant species can result in a significantly impoverished restoration.*

A second motivation for historical completeness in restoration projects is that speciose systems are more stable with respect to environmental factors (Putnam 1994:145–147). Walker has termed the existence of many species that serve similar ecological roles "ecological redundance" (Walker 1992; Lawton and Brown 1996). "Redundance" is not meant in a pejorative sense, but instead illustrates the importance of similar species being able to compensate functionally (e.g., fixing nitrogen) when another species population has declined (Walker 1995). Ecosystems (and restoration projects) lacking the ecological redundance that characterized the historic condition will be more susceptible to collapse.

## Ecotype Accuracy

The biological species concept (Mayr 1942) is inadequate for restoration purposes; rather attention must be given to local genetic variation in organisms known as "ecotypes" (Turesson 1922; Clausen *et al.* 1948). In a discussion of conservation biology, Rojas (1992) writes that, "Considering species as typological entities may … lead workers to disregard geographic variation and to neglect the problem of deciding which level of variability to protect." Rojas concludes that conservation biologists have neglected to understand species concepts relative to their work. We find that applied restorationists also pay too little attention to local, ecotypical variation. However, some writers have addressed the importance of local variation to the success or failure of restoration projects, calling it "the ecotype question" (Cairns 1987).

Scholarly discussion of the ecotype question generally has supported a position of striving for ecotype accuracy. McNeilly (1987) discussed the importance of local ecotypes in heavily degraded areas where plants may have adapted to the extreme toxic conditions of a site, stressing the continuing evolution of plant populations subject to contaminated conditions. Millar and Libby (1989) explored how to maintain a commitment to genetic purity while settling for something less. They note that genetic variation does not necessarily correspond to geographic variation and that one must also consider the microclimatic and edaphic conditions of individuals used for propagules. Proximity does not necessarily denote the appropriate ecotype for a restoration site. Read *et al.* (1996) note that the internal variation of some species (*e.g.*, *E. fasciculatum*) is much greater than others (*e.g.*, *Stipa* spp.) allowing the restorationist to make judgments about the necessity for site fidelity on a case-by-case basis.

Although the consensus seems to be that the restorationist should only collect propagules based on particular knowledge of the plants and locations involved, this precept is motivated by concern that plants themselves will survive and are genetically appropriate. However, *a restoration is not successful if the plants kill the organisms that depend on them.* While a plant of a non-local ecotype may survive when planted as part of a revegetation project, consideration rarely is given to the effects of the plant on other trophic levels. Insects, especially larval forms, give a rough indication of the divergence of different ecotypes.

Consider *Eriogonum fasciculatum*, which is a foodplant for a large number of insects and is widely used in restoration efforts. We have observed that *E. fasciculatum* shows large geographic variation, which often is overlooked in restoration efforts. We know of two restoration sites where a non-local ecotype was established as part of a restoration project (the Defense Fuel Support Point in San Pedro, and upper Newport Bay). At the Defense Fuel Support Point we do not know the source of the non-native ecotype, but it is visibly different from nearby local individuals and is characterized by a depauperate insect fauna, lacking many common species found nearby on the local ecotype. A few examples of the variation within *E. fasciculatum* involve rearing lepidoptera larvae for research purposes. We found a larva of *Hemileuca electra* (a saturniid moth) on *Eriogonum fasciculatum* near Jacumba, CA. It died after being moved to the San Pedro ecotype (Longcore and J. George, unpublished data). Several larvae of *Schinia* sp. collected in Riverside County on *Chaenactis glabriuscula* DC. died at once after consuming the ecotype from the El Segundo sand dunes (Mattoni, unpublished data).[2] To borrow a pun from tropical butterfly ecologist Phil DeVries, using the wrong ecotype "add[s] insult to herbivory" (DeVries and Baker 1989).

Research in the late 1960s and early 1970s by Paul Ehrlich and colleagues (Breedlove and Ehrlich 1968, 1972, Dolinger *et al.* 1973) explains the sensitivity of herbivorous larvae to this intraspecific variation. They found that lupine species (*Lupinus* spp.) subject to herbivory by a lycaenid butterfly (*Glaucopsyche lygdamus*) showed higher levels and compositional variability of alkaloids, compounds that serve as chemical defenses against the larvae. Further, they discovered that variation in alkaloid content and composition between lupine populations of the *same* species was often *higher* than the variation between populations of *different* species. Their work clearly shows the localized nature of the interrelationships between species (in this instance a plant-herbivore complex). For the restorationinst, Ehrlich's work illustrates the enormous importance of ecotype fidelity on the potential ecological function of a restoration site. With the exception of species whose genotypic and phenotypic variation are thoroughly explicated with respect to their associated herbivores, local ecotypes should be used in restoration.

## Type Conversions

Finally, we consider habitat type conversions, wherein the restorationist purposefully establishes one habitat type or vegetation association where it was not found historically. Such intentional or inadvertent type conversions constitute a particularly insidious form of historical inaccuracy. Historical accuracy is a difficult goal for restorationists because often little information is available in an accessible format. Jordan and Packard (1987) describe trial-and-error efforts to identify native plant species that would persist under oaks near Chicago. Early efforts had attempted to establish prairie species under the oaks, but further experimentation revealed that another distinct set of plants was adapted to such conditions. After discovering this fact, Packard happened across an 1846 journal called *The Prairie Farmer*, which had identified 108 species characteristic of "barrens," the settler term for natural oak savanna. While Packard was pleased to note that those species corresponded with his list of savanna species, complete historical research could have avoided the frustration of attempting to establish a prairie as the understory of oak savanna in the first place. Because of incomplete historical research, many restorations performed as mitigations may indeed be characterized by a such unintentional type conversions.

Similar examples can be found in southern California in a number of areas. Unfortunately, would-be restorationists obliterate the natural community in their attempts to establish the wrong vegetation type. For example, because of an error misinterpreting the extent of the El Segundo dunes (Arnold 1983:80, 1990:36; see Mattoni 1992:280 for details), some restoration attempts have tried to establish dune scrub vegetation in areas that were historically occupied by the distinct Los Angeles coastal prairie (Mattoni *et al.* 1997). It was only through close observation and historical research completed as part of the El Segundo dunes restoration that the prairie was recognized and described. We hope that the recognition and description of the prairie will inform future restoration efforts on the remaining fragments.

The most well documented instances of type conversions have been done as mitigation under Section 404 permits for the Clean Water Act administered by the U.S. Army Corps of Engineers (Allen & Feddema 1996). In a survey of 75 project sites, Allen and Feddema found that only 67% of the projects had been "successfully completed." Further, they found an overall decrease in wetlands with some types gaining (riparian woodland) while other types declined (freshwater wetland). Distribution of wetland types and overall regional wetland location was changed through the mitigation process. Zedler (1996) also documents and discusses the need for a regional plan to avoid continued replacement of the historic extent of one type of habitat (salt marsh and intertidal flats) with another (deepwater habitat), fueled by mitigation needs.

Conservation and Policy Implications

Our work with the El Segundo blue butterfly created the opportunity to learn what can go wrong in an ecological restoration project. The mistakes identified here occur on a regular basis in projects identified as "restorations." These projects, even when developed under the supervision of the U.S. Fish and Wildlife Service, the California Department of Fish and Game, the California Coastal Commission, or the U.S. Army Corps of Engineers frequently are historically inaccurate and incomplete, and pay little or no attention to ecotype accuracy or type conversions. Examples abound: the plan written for the Deane Dana Nature Center in Friendship Park in Palos Verdes proposes to restore coastal sage scrub with a plant list of about a dozen shrubs (out of approximately 150 plant species that can be identified for the site, many of which are no longer found in adjacent areas and will never recolonize naturally); the Ballona Lagoon "restoration" project commenced by bulldozing all vegetation

[2] These examples are illustrative only; many other factors may have caused the deaths of the larvae in question, including stress, bacteria, fungi, and viruses. Also, geographic variation between plant individuals may not be genetic, it may result from environmental factors such as differing concentrations of heavy metals in the soil.

(including natives) leaving no chance for ecotype accuracy; the Ballona Wetlands plan developed for the Playa Vista project converts historic salt marsh into a sediment detention basin surrounded by landscaping with native plants bearing little resemblance to the historic community found on the site (in addition to other marine community conversions, historical inaccuracies, and incompleteness).

Such ecologically deficient "restoration" projects could simply be avoided through better communication from the academic community to the resource agencies. Rather than relying entirely on their own overworked staffs, agencies should solicit peer review for restoration plans from qualified experts in the habitats in question who are free from conflicts of interest. Consultants proposing to design and implement restoration projects should be required to pass examinations indicating field identification skills and historical knowledge of the habitats they profess to understand.

One underlying reason for the continued acceptance of deficient restoration planning and implementation is the simple fact that few biologists choose to pursue careers in politics, in which realm many decisions are ultimately made. Rather, the political world tends to select for more people-oriented participants, who, through no fault of their own, lack a robust biological background. When entire elected bodies have not a single biologist in their midsts, they perforce rely on the opinions of others who may or may not have the proper expertise to advise on the issue at hand. Therefore, if ecologists in the academic community would like to see the fruits of their labors translated into more enlightened policy, more outreach to local and regional policymakers will be required.[3] This conference and its predecessor have in some part served that role.

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[3] Perhaps the time has also come for conservation biologists to run for local elected office and to seek positions on planning commissions and similar land-use jurisdictional bodies.

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