Conservation Matters: Contributions from the Conservation Committee

Flying towards recovery: conservation of Fender's Blue Butterfly

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In 1980, Fender's blue butterfly (*Plebejus* = *(Icaricia) icarioides fenderi (*Macy)) was a little known butterfly. It was noticed by a mailman, Kenneth Fender, in 1937, and soon thereafter was forgotten and thought to have gone extinct. That all changed. In 1988, Paul Severns, 12, collected half a dozen Fender's blue, but his guide included Fender's blue so he did not consider the sighting noteworthy. The following year Paul Hammond, a lepidopterist, was searching for Fender's blue in the small and dwindling fragments of Willamette Valley prairie, and found a cluster in the hills near Corvallis in western Oregon. His encounter made the New York Times.

Today both Pauls are part of the effort to conserve and restore Fender's blue, and all of the native species that inhabit Willamette Valley prairies. Over the last two decades, a dedicated group of scientists, managers and landowners have worked collaboratively to find the butterfly, identify its needs, develop recovery strategies, and work towards its recovery. In a nutshell, Fender's blue has gone from a few dwindling, isolated remnants of prairies, to a systematic network of sites with growing populations that have the potential to achieve the recovery goal.

Fender's blue (federally endangered) is a small univoltine butterfly. Males have iridescent blue wings and females have rich rusty brown wings. They are found exclusively in prairies that maintain its larval hostplant, Kincaid's lupine (*Lupinus oreganus* = *L. sulphureus spp. kincaidii*, federally threatened), spur lupine (*L. arbustus*) and occasionally sickle keel lupine (*L. albicaulis*). The adults fly in May, females oviposit, and pre-diapause larvae feed until its hostplant senesces in late June. The following March, individuals emerge from diapause, feed on newly developing lupine leaves, pupate in April, and eclose as adults again in May.

Fender's blues' prairies have almost disappeared. Less than 1% of the Willamette Valley prairies remain, and most of the remnants are small, isolated and dominated by invasive plants. The landscape is a mosaic of pastoral vineyards, orchards, and grass-seeds farms, interspersed with the small to large cities of Corvallis, Eugene, Salem and Portland. Public land is scarce. As a consequence, conservation of the prairie ecosystem has required a concerted and collaborative effort to engage landowners and the public from across a spectrum of backgrounds.

My part in this story is as a scientist who grew from a green graduate student to a tenured faculty member now at Washington State University with Fender's blue as my focal story. As a naïve young and idealistic graduate student of 24, I was looking for a system in which I might have an opportunity to make real contributions to conservation. As a college student in the years of the Northern Spotted Owl debate, I was wary of environmentalists painting issues as black and white, or good and evil. Instead, I saw science as a path to construct solutions that would both protect the environment in balance with needs of people living in that environment. This led to my overall approach to science. Each project I embark on stems from the basic question of how to integrate ecological theory with natural history of species-at-risk to address questions we need answered to take steps forward.

Here are a few stories to highlight this wedding of science with application. The question that motivated my thesis work was "Will corridors work?" In this case, the West Eugene Wetlands Partnership was interested in constructing a corridor of lupine along the narrow banks of a diversion dike which led from Eugene to Fern Ridge Lake, a reservoir constructed by US Army Corps of Engineers in the 1930s. The West Eugene Wetlands was then a partnership of the City of Eugene, The Nature Conservancy, and Bureau of Land Management (BLM), and now includes many other partners. To answer this question, I needed to figure out 1) if a butterfly would stay in a corridor, and 2) do they fly fast enough to get between isolated patches in their lifetimes, whether inside or outside of a corridor. By the time I was done, I'd figured out that stepping stones would be a much better option for the butterfly (Schultz 1998, in Schultz and Crone 2015). And, the stepping stones were a much more practical option because a network of stepping stones has a lot of flexibility in terms of where land is restored and the size of each stepping stone. The managers, biologists, and agencies liked this approach because it gave them guidance without being too proscriptive.

While in graduate school, I started working with Elizabeth Crone, then an NSF postdoctoral fellow, now a Professor at Tufts University. She is a theoretical ecologist gifted with the creativity and ingenuity to find methods to answer questions in ways that are unique in the field. Together we tackled the question, "Burning for Butterflies?" to ask if fire would lead to net costs or net benefits for this endangered butterfly. With a combination of very limited experimental data and a quantitative model, we found that fire kills the larvae, but enhances the habitat and leads to more eggs – such that the benefit far outweighs the costs (Schultz and Crone 1998, in Schultz and Crone 2015). Here, too, we could give some practical guidance. You can't burn everywhere, because it would singe all the larvae. Instead, burning about 1/3 of the occupied area of a site every couple of years gives the best overall benefit, but there are many good ways to apply the strategy.

Fast forward to today. We spent the next two decades in discussions about how to use science to find practical "rules of thumb" that would help conservation, and most of our collaborative work uses Fender's blue as a model species. Thus, our work, in concert with active discussions from biologists, managers, property owners and the public, led to framing questions that would help advance Fender's blue conservation and answering questions with the intention of providing flexible guidance that people could use on-the-ground and in their work.

Part of our work has been integrating research into the development of recovery criteria for Fender's blue. These criteria are the standards USFWS uses to judge if a species is recovered and therefore can be downlisted to threatened or delisted and taken off the list. We just published the full story in a "Practitioner's Perspective" in Journal of Applied Ecology (Schultz and Crone 2015). In a nutshell, we developed three "rules of thumb" that integrate ecology and natural history of Fender's blue into criteria to guide recovery. First, patches should be about 2 km apart for functional connectivity. This came directly from my thesis work that included dispersal-based studies to quantify how far a butterfly might fly if it spent its entire lifetime outside of lupine patches. This is admittedly an unrealistic assumption – butterflies always spend time in lupine when they first eclose as an adult – but it gives the maximum distance they might fly if they left their natal patch as soon as they eclosed.

Second, Fender's blue requires a minimum of 6 hectares of high quality lupine habitat to support a population if in isolation from other suitable sites. This both relates to core habitat needs as well as movement behavior such that the butterflies need large enough habitat patches to stay long enough to lay enough eggs to replace themselves. Resources are clearly important, and our work has contributed to setting target goals for resources based on the relationship between resources and population size. However, this criterion emphasizes that the marriage of resources, behavior and population dynamics, not just resources, is critical to evaluating patch size requirements.

Third, we measure recovery by minimum (not average) population size for the acceptable level of extinction risk set by US Fish and Wildlife Service (USFWS). For Fender's blue this minimum is 1000 butterflies in each network (not each patch) and 9 networks across the full range of Fender's blue. This is based on population dynamics of the butterfly and theoretical predictions about extinction risk grounded not in the average population sizes, but degree of variability in population size from year to year and ensuring the population never falls below the minimum in any given year. As with other criteria, flexibility is built into the framework. We worked with agency biologists to create a "look-up" table in the Recovery Plan with combinations of sites and population sizes to reach this minimum.

This criterion has met the most resistance of the three because it requires network population size be maintained above the minimum every year for 10 years. As part of this, it requires surveys in every year, even poor weather years, because extinction risk is most sensitive in the low years. In addition, it means that if we discover a new population, it can't "count" towards recovery until we have monitored for 10 years without dropping below 1000. This is quite important given the inherent variability in Fender's blue population sizes, which is a similar feature across many butterfly species. For example, a new site was discovered a few years ago with almost 2000 butterflies. In the time since discovery, it has plummeted to less that 500 butterflies. Similarly, a newly reintroduced site just suffered a setback when an August 2015 summer fire scorched dozens of acres near the heart of the reintroduction area. However, the need for annual population assessments has also led to development of a systematic monitoring protocol that can be applied across the species' range but is flexible enough to focus limited financial resources on sites and networks that will "count" towards recovery as well as sites in which we have active research to improve our ability to restore and manage Fender's blue and its habitat. The work to develop and implement the new monitoring protocol was led by Greg Fitzpatrick and Tyler Hicks, two private consultants, in close collaboration with USFWS.

These setbacks are far outweighed by the positive trends we see today. We estimated fewer than 3,000 butterflies throughout its range in the early 1990s. In 2014, we estimated more than 17,000. Although some of this increase is likely due to a switch in monitoring methodology in 2012, much of it reflects recent restoration and management efforts. With a Recovery Plan in place, and the cooperative and collaborative effort of many, we are now seeing successes across in multiple locations. Given focal restoration efforts, in part guided by rules of thumb to select size and location of important sites, populations are flourishing. At one site, The Nature Conservancy's Willow Creek Natural Area, a 12-hectare old hayfield was restored "from scratch" to native prairie and the population has recently climbed to over 700 butterflies. At BLM's Fir Butte area, the site had plentiful hostplant lupine but was overrun with weeds and nectar resources were scarce. Diligent work over the last decade to reduces weeds and enhance nectar is just now starting to pay off. The population dropped to just a few dozen butterflies in the 1990s, but has since grown to 1600 butterflies in 2014 and we estimate over 2200 butterflies in 2015. A key lesson from both of these is that restoration takes time. The work at Willow Creek took years to discover how to augment the supply of Kincaid's lupine seed, which is also a listed species, and then another decade of experimental work to learn how to implement large scale plantings. At Fir Butte, Tom Kaye at the Institute for Applied Ecology, has worked closely with Sally Villegas, a biologist with BLM, to experimentally investigate aggressive management techniques followed by concentrated nectar plantings that took nearly a decade to establish.

Similarly, USFWS is working with interested private landowners to enhance and protect habitat. They use the range of regulatory and incentive tools within their toolbox to find the right tool to work with interested parties. This includes Safe Harbor Agreements, Habitat Conservation Plans, easements and much more. Mikki Collins, lead Fender's blue biologist for USFWS, and Steve Smith, a recently retired Private Lands biologist for USFWS, have been at the helm of working creatively across numerous parties, interests and people to achieve conservation goals that are rooted in science across the Willamette Valley. For example, a new site with significant potential was discovered in the early 2000s. The site is privately owned and within dispersal distance of a USFWS refuge with an important population Fender's blue butterfly. The site had lupine, but little nectar. The landowner was able to work with Steve Smith to put regulatory protections in place and then substantially enhance nectar. The site is just now seeing those efforts translate into butterflies increasing at the site. Other successes include involvement across the community. In one sphere, 2015 saw the largest planting of Kincaid's lupine to date. As part of the Sustainability in Prisons-Oregon Project, a partnership of USFWS, Institute for Applied Ecology and USFWS, women at the Coffee Creek Correctional Facility raised and planted over 20,000 Kincaid's lupine seedlings at two National Wildlife Refuges. In another sphere, Willamette Partnership and USFWS are working with Willamette Valley vineyards to augment Fender's blue habitat within the vineyard landscape and craft an ecolabel certification process that will enhance visibility and marketability of participating vineyards.

The story of Fender's blue is a story of many people dedicated to butterflies and conservation and the confidence that science can help us advance conservation in a human-dominated landscape. As a result, Fender's blue is flying towards recovery.

Cheryl Schultz is an Associate Professor at Washington State University. She is a conservation biologist and has been working with Fender's blue butterfly and other prairie butterflies for over two decades. She is co-leader of USFWS Recovery Team for Western Oregon and SW Washington Prairie Species, which includes Fender's blue butterfly.

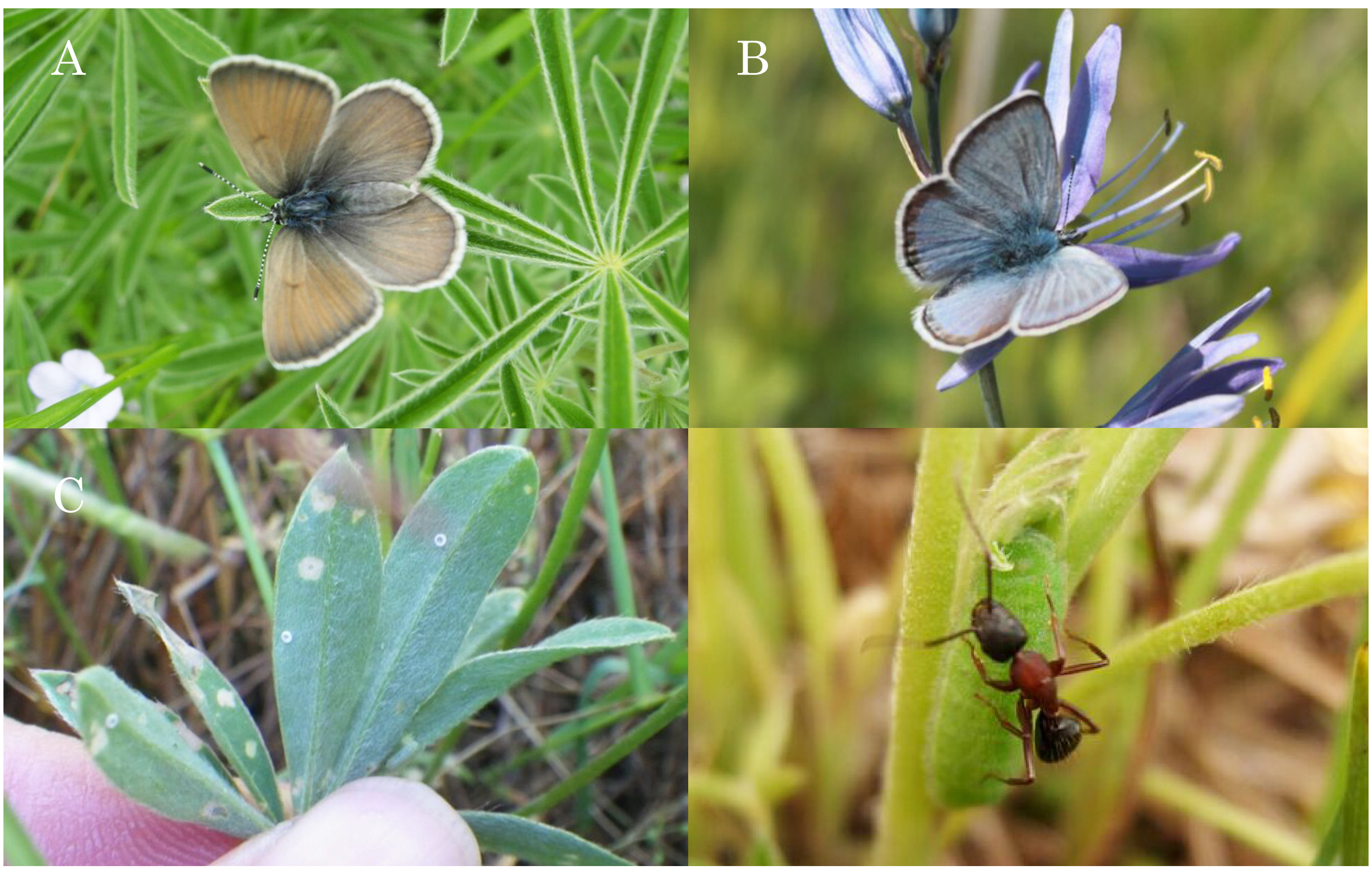

Fig. 1. Fender's blue butterfly a) Female perched atop a Kincaid's lupine leaf, b) Male basking on camass (*Camassia quamash*), a favorite nectar species in the early part of the season, c) Fender's blue hatched eggs and pre-diapause larvae (near tip of thumb), and d) post-diapause larva tended by an ant.

Fig 2. Cheryl Schultz and research crew at a site near Corvallis, OR in 2008. From left are Alexa Carleton, Alan Kirschbaum, Angela Little, Cheryl Schultz, Alex Martin, Michele Hansen, and Aldina Franco.

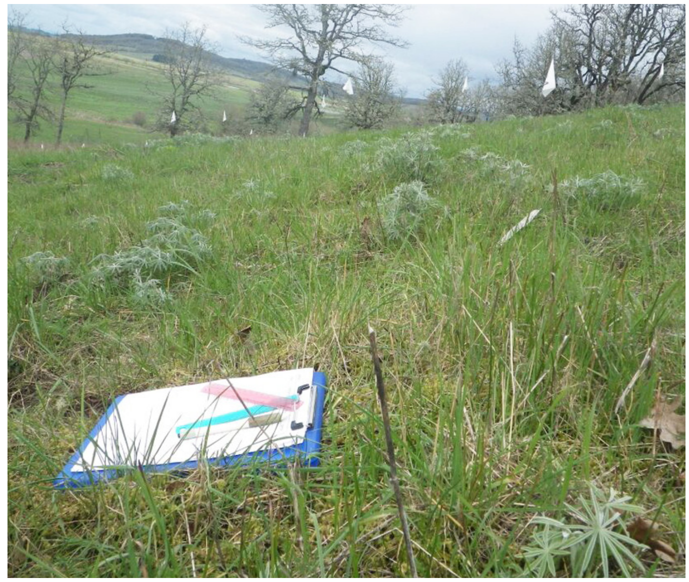

Fig. 3. Research at Baskett Slough Nat'l Wildlife Refuge, one of the largest remaining populations. Clumps of hostplant lupine across the prairie in early spring when post-diapause larvae are active. By late spring, when adults are flying, invasive tall grasses overtop hostplant lupines and nectar sources at most sites.

Figure 4. Restored prairie at The Nature Conservancy's Willow Creek Natural Area.

Literature Cited

Schultz, C.B., and E. E. Crone. 2015. Minimum patch size, minimum population size, and maximum inter-patch distance: Using ecological theory to develop recovery criteria for an endangered butterfly. *Journal of Applied Ecology* 52: 1111-1115.