Defining the need

The Laguna de Santa Rosa, in Sonoma County California, is a biologically rich freshwater wetland complex which has retained much of its wildland character even as its surrounding neighborhoods have been converted to agriculture, commerce and housing. The Laguna has remained relatively strong and resilient in the face of severe pressures from habitat fragmentation, water pollution, floodplain encroachment, and urban development. Meanwhile, the general public perception of the area as a "wetlands jewel" has resulted in a widespread outpouring of public sentiment in support of its protection and restoration.

But a deeper look at the wetlands reveals a long list of ecological imbalances that portend a darker future. And the need for enhancing the Laguna becomes clearer when the historical record is examined—most notably the record of the land's great fertility and its former abundance of wildlife and diversity of plant life. When compared to today's remaining, simpler, less-diverse, plant and animal communities, the contrast is sharp—and a sanguine outlook for the future is not expected by simply sticking to the *status quo*.

Enhancing the Laguna, by removing invasive plants, by planting native plants, by recontouring man-made water channels, and by reducing water pollutants, is a fundamental goal of the area's citizens. Caring for the Laguna, by monitoring for changes, by wisely stewarding the land, by educating our children, by studying the ecological processes of the Laguna, and by enacting public policy, goes hand-in-hand with enhancement activities. Restoring and managing the Laguna—or *Enhancing and Caring for the Laguna*—are complementary sets of activities that together will strengthen the Laguna's ability to reach a balanced state of flux and resiliency.

The need for a comprehensive look at the physical and biological functioning of the Laguna de Santa Rosa was defined in 2003 by the Laguna de Santa Rosa Foundation, shortly after its publication—with the Sonoma Land Trust—of the *Laguna Resource Atlas and Protection Plan*. That publication represented a snapshot of the watershed's then-existing data pertaining to endangered species, flooding, land use planning, and open

space protection. The Atlas, in turn, had its genesis in an earlier publication, the *Laguna Coordinated Resource Management Plan*, prepared in 1995.

The latest look at the Laguna, by design, is intended to leverage the existing body of work, and to extend it through the concerted efforts of the Laguna's broad community of stakeholders. This report, *Enhancing and Caring for the Laguna*, represents the latest findings and recommended courses of action to be taken concerning the preservation, restoration, management and long-term monitoring of the Laguna's natural resources, as defined by the stakeholder community. This new look represents a different approach—a more active, ongoing, community-oriented approach—a way of making good decisions, based in science, balanced with the human needs of the citizenry, and most importantly, always forward-thinking.

Working with the community

In 2004, a Stakeholder Council was convened for the purpose of defining and articulating clear goals for the Laguna. This was done through facilitated sessions that gave equal voice to all participants. Broad goals for healthy habitats, biologically diverse plant communities, clean water, and good land stewardship practices were easy for this group to state. But more detailed goals for each of these required deeper thinking, open-mindedness and a learning posture on the part of participants. One of the breakthrough sessions occurred when stakeholders were asked to imagine themselves, in the year 2030, describing what the Laguna looked like at that future date, and what had transpired in the intervening 25 year period: this backward glance helped the participants to look at the big picture and enabled them to shape that big picture into a common vision for the future of the Laguna.

On a coincidental timeline with the Stakeholder Council, four advisory committees were formed to discuss problems and opportunities related to: 1) water quality, 2) hydrology, 3) biological diversity and wildlife, and 4) public access and recreation. A separate advisory committee was also created to provide a forum for farmers and ranchers to share their ideas and recommendations for the Laguna. But the community's involvement in formulating the ideas for this plan was not limited to the Stakeholder Council and the advisory committees: many volunteer and professional consultants helped to shape the ideas for this plan throughout the duration of the project.

Stakeholders came from many groups, including:

- Public regulatory and enforcement agencies
- Public resource land managers
- Local ranches and farms
- Public planning and public policy commissions and associations
- Organizations working on conservation acquisitions and conservation easements
- Non-governmental advocacy groups and trade associations
- Federal and state public research services
- Regional resource conservation districts
- Nearby conservation research facilities
- Local conservation education groups
- Citizen-led watershed organizations

Charting a course

The all-encompassing statement of goals for the Laguna, as expressed by the stakeholders, is simple:

> *"To preserve and enhance the Laguna de Santa Rosa watershed through ecological restoration, research, and care that supports biological diversity, improves water quality, provides flood protection, enhances groundwater resources, and provides for human needs, thereby leaving a lasting legacy for future generations."*

This statement is clarified through specific high-level goals which include: 1) restoring native habitats and enhancing biological diversity, 2) restoring the Laguna's waterways to dynamic equilibrium while reducing waterborne pollution, 3) actively managing and monitoring the health of the public lands and private preserves of the watershed, and 4) establishing a center for wetlands research. For each of these high-level goals, detailed objectives have been established and individual recommendations have been made towards reaching each high-level goals.

Under the broad category of habitat restoration and management, objectives include: working toward self-sustaining ecosystems; designing restoration projects that mimic the biological and structural diversity of native habitats; improving the effectiveness of restoration projects through research, monitoring, and adaptive management practices; and preserving biological diversity by limiting the spread of aggressive invasive species.

Towards habitat diversity, the principal objective is to preserve the watershed's diverse plant communities, with high priority recommendations

made towards enhancing riparian corridors, developing environmentally-appropriate urban waterway plans, and developing management regimes to enhance native grasslands.

Towards biological diversity the principal objectives include implementing the California tiger salamander recovery plan, enhancing the vernal pools of the Santa Rosa Plain, restoring anadromous fish passage, and preserving the watershed's rare plants while "keeping common species common."

Under the category of water resources the principal objectives include re-establishing dynamic equilibrium to the watershed's channels, floodplains and aquifer recharge areas. These hydrologic and hydraulic efforts should be coupled with pollution reduction efforts targeting water temperature; dissolved oxygen levels; and excessive nitrogen, phosphorus and sediment.

To support these objectives, a strong science program should be institutionalized, a good organizational framework for data storage and retrieval should be established, eductional programs for adults and children should be strengthened, and broad community outreach efforts should continue.

Restoring, managing & monitoring habitats

The fundamental basis for restoration activities in the Laguna is functional. Natural environments provide ecosystem services: cleaning the air and water, moderating flooding, and supporting diverse plant and animal communities that naturally control pests, pollinate crops, and bring beauty and meaning to our lives. In time, the Laguna will "restore" itself—trees will grow, wetlands will rise or fall, and creek channels will find their own meandering pathways. But such passive restoration can take a long time, and in the long intervening years, certain fish and wildlife species may be lost from the system. Natural succession in degraded systems can receive a boost through active restoration efforts.

Biological diversity is built on biological diversity. Restoration practices focus on enhancing existing plant populations and supplementing those populations with missing, but otherwise naturally occurring, native plants and trees. Stability is based on ecological feedbacks, and these feedbacks are more common among species that have evolved together over time. As a general rule, restoration projects should use locally derived sources of trees, grasses and other forbs. Restoration projects are usually initiated according to both need and opportunity, but whenever pos-

sible projects should be designed to form links between existing areas of habitat—increasing the size of large, contiguous habitat areas, or forming corridors between habitat patches.

Monitoring has been chronically under-funded, and fixing this will require a reassessment—on the part of grantors—of the benefits gained through monitoring, and the risks assumed by not monitoring. The mindset that "nature will take its course and everything will be fine" is naïve and leaves otherwise successful restoration projects susceptible to long-term failure.

Vernal pools

The Santa Rosa Plain is pockmarked with numerous vernal pools that are host to declining populations of threatened or endangered Sebastopol meadowfoam, Burke's goldfields, Sonoma sunshine, Many-flowered navarretia, Baker's navarretia, Dwarf downingia, Gairdner's yampah, Douglas's pogogyne, and Lobb's aquatic buttercup. Vernal pools are also host to the endangered California tiger salamander (CTS).

The Laguna's vernal pools and swales are widely recognized as a key and characteristic habitat, supporting many rare plants and animals. The unique hydrology of these pools—holding water past the rainy season—comes from thick underlying clay layers which in summer are cracked and dry. This harsh environment has favored the evolution of unique and specially adapted communities of plants and animals. Both CTS and the listed plant species have been heavily impacted by habitat loss and fragmentation. Vernal pools and swales exist in a matrix of uplands, and to be successful, vernal pool restoration must be accomplished in tandem with grassland restoration.

The significant loss of vernal pool habitat in California's Central Valley underscores the importance of local efforts towards enhancement in the Santa Rosa Plain. The implementation of the *Santa Rosa Plain Conservation Strategy* is viewed as a creative alternative to the establishment of critical habitat by the US Fish and Wildlife Service. One of the most important considerations in designing this implementation plan is the need for an adequately funded preserve management team, including a preserve coordinator, scientific researchers, and a staff of vernal pool land managers.

Floodplain

Much of the higher floodplain should be restored to riparian forest—especially areas extending out from the main Laguna channel. Northern harriers, white-tailed kites, egrets, herons, and many perching birds hunt or forage on the floodplain which in the winter form large shallow lakes favored by ducks, geese and other waterfowl. Without restoration and management, the Laguna's annual floodplains are at serious risk of being overtaken by invasive species. The greatest threats now present in the Laguna floodplain are perennial pepperweed, purple loosestrife, and several perennial bunchgrasses, including Harding grass and reed canary grass.

Open water wetlands

Freshwater lakes and ponds in the Laguna bottomlands provide habitat for warm water fish and their predators including, among others: eagles, black-crowned night-herons, cormorants, and pelicans. The size and location of the Laguna's long-lost lakes are well documented in historic 19th and early 20th century maps. Interestingly, these lakes expanded and contracted more than once in the past 150 years—in part because of the dynamic nature of the Laguna—as it has been reconfigured by sediment, floodwaters, and human intervention. The Laguna's lakes were drained and filled during the 20th century, and this habitat type is now nearly lost. One of the best opportunities for bringing back this habitat may be to restore the California Dept. of Fish and Game's *Laguna Wildlife Area*, located just north of Occidental Road. Accomplishing this will require good planning, extensive permitting, and the cooperation of nearby private landowners.

Perennial marshes

Tule marshes were a signature California habitat throughout the Central Valley and in other inland freshwater wetlands. They are now almost entirely gone: drained and filled, converted first to farmland and then to housing. A study of old survey maps—from the USGS and their predecessors—reveals a dramatic loss of perennial marshes in the Laguna over the past 91 years. In the most impacted area, between Occidental Road and River Road, the extent of freshwater marshes has diminished significantly: in 1915 there were approximately 540 acres of shallow emergent wetlands; at the present time, 2006, only 160 acres of this habitat type remain in this reach. In addition to this dramatic quantitative loss, there has been a very significant qualitative loss: the remaining perennial marshes

are heavily infested with weeds, nearby riparian forests have been further degraded due to changing water levels, and polluted water keeps predator and prey species at artificially reduced levels.

Riparian forests

Riparian forests—the dense, multi-storied zone of willows, alders, ash, rose and berries found next to creeks—form a transition area between the saturated soils of creek embankments and the drier soils of upland meadows and prairies. There is a tremendous need for riparian restoration in the Laguna watershed. Using satellite imagery from 2001, we found that 51% of the creeks in the Laguna watershed were completely lacking in stream canopy. Fortunately, riparian areas are able to quickly restore themselves when continuous pressure from grazing livestock and human encroachment are removed. Research further shows that this type of simple, passive restoration, when compared to active restoration, can result in an equivalent amount of woody species within just a few years. But while passive restoration is a good first start, active restoration is needed in order to reestablish a wider diversity of distinct native species.

Riparian restoration integrates across almost all watershed-level restoration objectives in the Laguna: habitat connectivity, biodiversity, water quality, and flood protection. And healthy riparian areas are essential for fish and wildlife. Greater grazing control along stream banks is an essential starting point to restoring healthy riparian areas; when supplemented with well-planned active restoration, riparian forests can quickly achieve an increased diversity of plant life and an increased abundance of wildlife.

Grasslands and oak savannah

Most Laguna grasslands are working landscapes, grazed by a variety of livestock, or used for the production of feed crops. Over the next decade, citizens in the Laguna watershed will be challenged to find ways to support an economically viable ranch and dairy economy, while restoring the environmental function of grasslands. In conjunction with implementation of the Santa Rosa Plain Conservation Strategy, restoration projects that focus on grassland enhancement will become an important effort, one which can meet multiple ecosystem objectives. But grassland restoration is not easy, and to be successful intensive management will likely be needed for several consecutive years.

Present-day management efforts are mostly concerned with discouraging the growth of non-natives. Livestock grazing, along with burning, closely reproduces a natural ecological process. In the Laguna, like elsewhere in the world, grasses have co-evolved with grazing animals and can be very productive while retaining their habitat quality. Controlled burns are the most traditional and perhaps the most effective grassland management technique; correctly timed, low-intensity grass fires are effective for promoting native grasses and wildflowers. Mowing and haying are two other active management techniques suitable for large-scale grassland restoration efforts in the Laguna.

Oak restoration

Valley oaks are emblematic of the Santa Rosa Plain and provide exceptional habitat for many species of birds, animals and insects. Garry oaks, California black oaks and coast live oaks are also found on the Plain, and a number of other species occur in the oak woodlands of surrounding hillsides. Throughout California, few young oaks are found among the aging groves, and in many places the oak savannah has grown thin. Regular disturbance through mowing, disking and grazing are likely the most limiting factors, destroying otherwise viable recruits. But despite recent population declines, there is real promise for oak restoration in the Laguna watershed: where seedlings are cared for, they have high survival rates and grow rapidly.

Controlling invasive species

The term *invasive* is generally used to describe plants and animals that have the capacity for explosive population growth, becoming widespread and eventually dominating ecosystems. The emphasis on native plants and animals in ecological restoration is simple: indigenous species are much more likely than exotic species to have evolved mutual ecological relationships with local predators and competitors. Indigenous species thus provide a balance that naturally allows for biological diversity and abundance.

Controlling weedy plants and animals is a necessary part of land management in the Laguna, but the fundamental goal is to increase the self-sustaining ability of the Laguna's ecosystems to resist invasion by weedy species, and to prevent the introduction of new weeds. After prevention, the most effective management approach to invasive species are programs that employ a policy of "early detection and rapid response." Weed map-

ping and monitoring programs are essential for early detection and rapid response to initial infestations, and are a central component of adaptive management frameworks for large-scale invasive species control.

The restoration practices that are most likely to suppress invasive species include: aquatic nutrient reductions, restoration of hydrologic conditions, and restoration of healthy riparian corridors. Reducing soil disturbances can also help to forestall the colonization of new territories. Biological control—introducing specialized herbivores, predators or pathogens—can be a very effective management solution, bringing populations of the invader to low, sustainable levels. Controlling weeds with grazing animals is another form of biological control, and has many advantages.

There is always a tension between the need for management action and the ability for science to provide rapid answers. Although it is sometimes necessary to move forward with incomplete information, whenever possible, invasive species control projects should include a research component to help plan and evaluate the success of management actions.

Preserving biological diversity

Historical accounts of the Laguna describe a very different landscape, highly productive, and filled with wildlife—some of which disappeared in the 19th century: Tule elk, pronghorn, wolves, grizzlies, beavers and California condors. Other species have been extirpated within recent memory: yellow-billed cuckoos, porcupines and badgers. Some species are on the verge of disappearing from the watershed and sightings are infrequent: California mountain lion, bobcat and river otters. Several plants and animals are *endemic* to this area of Northern California—naturally occurring nowhere else on Earth—and the joint forces of environmental change and development have put their populations at risk of extinction.

Preserving the diversity of the Laguna's plants and wildlife is a core value expressed by biologists and codified through treaties and laws such as the Migratory Bird Treaty, Endangered Species Act, and Clean Water Act. Fifteen plants and animals still found within the Laguna are federally listed as threatened or endangered, and thirty-eight are listed by the State of California as threatened, endangered, or species of special concern. In addition, the California Native Plant Society has designated forty-three plants as species of local concern. (A tabulation of all these species appears in appendix B.) But in compiling the list of threatened and endangered species, the Biodiversity Advisory Committee was concerned with common

species as well—species should not have to be at the edge of extinction to be the target of conservation efforts.

Anadromous fish

Anadromous fish, including steelhead, coho and chinook salmon were historically present in large numbers along several of the Laguna's major tributaries; these species were the foundation of an economically important fishing industry in the Russian River basin, but their populations have crashed in response to a variety of factors—including habitat degradation of spawning areas, and the occurrence of overly warm, oxygen deficient, silt-laden waters in the Laguna's main channel. Restoration activities should be designed towards the recovery of all three species, with greatest recovery, in numbers, foreseen for steelhead. The most important and least costly activity for salmonid recovery is enhancement of riparian canopy. Special emphasis should be given to Mark West Creek, Santa Rosa Creek, and Copeland Creek, with particular attention given to enhancing safe passage through the Laguna and the low velocity channels that cross the Santa Rosa Plain.

Sustaining our water resources

The Laguna watershed has a complex and diverse hydrology—cool-water, high-gradient creeks in the upper watershed flow down the hillsides to the broad, flat, vernal pool-dotted Santa Rosa Plain, meeting the warm, slow-moving Laguna main channel, that flows northward to join the Russian River. The diversity of Laguna wetlands is a central reason for the Laguna's biological diversity. Vernal pools and swales, sedge-dominated high marshes, tule-dominated low marshes, seasonal floodplains, and perennial creeks and streams all support different plant and wildlife communities.

Historically, streams flowing down from Sonoma, Taylor and the Mayacama Mountains formed broad alluvial fans as they deposited sediments over the east side of the Santa Rosa Plain. Today though, these alluvial processes are constrained because of our need to protect property from damaging floods. But flooding, erosion and sedimentation are natural, desirable processes in a well-functioning stream ecosystem and are thought to be essential for maintaining biological diversity. Over the long term, flooding and the detrimental effects of sedimentation can be alleviated through a combined set of practices, including: stabilizing stream banks, reducing upland sources of erosion, restoring riparian forests, retaining

aquifer recharge areas, protecting the floodplain from encroachment, wisely managing vegetation in urban creeks, and selectively removing accumulated deposits of sediment from key areas.

Sedimentation

Coordinated, watershed-scale studies and modeling are a critical first step for developing a baseline characterization of the watershed and predicting future changes in year-round water dynamics. The Sonoma County Water Agency (SCWA) and US Army Corps of Engineers (USACE) are evaluating flooding patterns in different parts of the watershed. Together they co-sponsored the Sedimentation Study, which provides a predictive model for the rate and fate of sediment delivery in the Laguna, showing the contributive levels of sediment expected from each of the Laguna's sub-watersheds. Currently SCWA and USACE are working with the US Geological Survey to model sediment transport through portions of the Laguna main channel: when complete, this model will provide an understanding of how water-borne silt is moving (or not moving) through the middle and lower reaches of the Laguna from Highway 12 to the Russian River.

Flooding

Accelerated changes in flood levels and water retention on the floodplain will affect the long term viability of restoration projects: areas that are constantly inundated will not be suitable for riparian plants. The recent rapid changes to the surface and sub-surface water table has triggered large changes in the middle reach of the Laguna: many acres of former riparian forest have died from overly-saturated soils and have been replaced by the invasive exotic water primrose (*Ludwigia sp.)* In order to understand these changes to floodplain dynamics and to plan for successful restoration of impacted sites, better data are needed. As a start, a more comprehensive set of stream gauges for collecting stage and discharge readings is essential: these would help in the development and calibration of predictive hydrology models. Similarly, a comprehensive set of rainfall gauges, especially ones distributed over the mountainous portions of the watershed, would be valuable for water budget models. Together with these proposed data collection stations, a better survey and analysis of topography, canopy cover, impervious surfaces, and land use patterns is called for; these will yield valuable information that can be applied towards many different kinds of restoration efforts.

Pollution

Water quality in the Laguna has been a challenge for decades. Although pollution levels in the Laguna today are a vast improvement over the days when regulations were lax or non-existent, more progress is needed. The most recent Environmental Protection Agency 303(d) list of impaired water bodies, prepared in 2004, includes listings for the Laguna de Santa Rosa, Santa Rosa Creek, and Mark West Creek sub-basins—which collectively form the working definition of the greater Laguna watershed. These sub-basins are considered to be legally impaired for having excess nitrogen, excess phosphorus, elevated water temperature, low dissolved oxygen, and excess sediment/siltation.

Although we have a general understanding of the Laguna's water quality concerns, we have yet to quantify either the sources or the effects of particular pollutants. A Total Daily Maximum Load (TMDL) process should be initiated to address the Laguna's water quality impairments. This process should work towards the initial goal of developing a basic understanding of pollutant sources, and should work towards the subsequent goal of developing policies and management practices that can eliminate, or reduce to acceptable levels, these impairments.

Part of the solution will come through implementation of the Storm Water Management Program, developed by the City of Santa Rosa, the County of Sonoma, and the Sonoma County Water Agency. Part of the solution will come through better nutrient management systems put in place through the Resource Conservation Districts working in partnership with local livestock operators. And part of the solution will come through open space acquisitions and habitat restoration of riparian areas.

The IRWP, or Incremental Recycled Water Program, is the Laguna Subregional Wastewater Treatment Facility's plan for disposing of treated wastewater during the next fifteen years. For the past couple of decades, agricultural and urban irrigation has been an innovative and important method for reusing this water. The Geyser's pipeline, since it came online in 2004, has added a second important endpoint for this resource. When winter rains eliminate the need for irrigation, and when the Geyser's daily capacity to receive water is met, excess water is pumped to storage ponds for later summertime use. But when this wintertime storage capacity is exceeded, treated wastewater needs to be discharged into either the Laguna or the Russian River. Direct discharges of wastewater to the Laguna should be phased out as soon as possible.

Working adaptively over time

Restoration priorities will evolve over time as new challenges and opportunities arise. The most likely evolution of these activities will proceed through a series of steps that will include: 1) *resource*-specific problem identification or *site*-specific opportunity identification; 2) remediation activities such as invasive plant control, pollution reduction, or hydraulic changes; 3) revegetation activities; 4) seasonal and annual land stewardship activities; and 5) data gathering, research, and monitoring activities. This cycle of restoration and management activities allows for an iterative feedback loop, where activities at each step in the process supply important information for subsequent steps. Most importantly, there is no end-point: successful restoration does not stop when the plants are in the ground or when the trees reach a certain height; restoration continues seamlessly with management, monitoring, and research efforts. These assure the success of revegetation efforts, measure the quality of habitat improvement, and provide statistical information on success and failure. In turn each step provides the data needed to confidently move to the next step. This continuous cycle of planning, remediation, revegetation, stewardship, and monitoring is the *adaptive restoration and management* framework.

Adaptive restoration and management, is well served by good organizational tools. These include data management tools, information dissemination tools, and research administration tools. Data management tools include databases to store and retrieve project information as well as geographic information systems (GIS) for analyzing spatially represented data. Closely tied to these tools, the proposed Laguna Ecosystem Database and the well-established California Environmental Resources Evaluation System (CERES), are two important data repositories for Laguna related work. Information dissemination tools include Internet web sites, FTP data exchange servers, email list-serves, journals and newsletters. Among these the Russian River Interactive Information System (RRIIS) is an important local resource. Research administration tools include basic calendaring, spreadsheet and mapping software that assists and coordinates research programs that cross disciplinary boundaries. This type of organizational oversight helps leverage volunteer efforts, helps dovetail similar programmatic efforts, and helps prevent accidental site-related problems that can arise when many researchers share test plots.

Place based decision making

Place-based decision making is a smart way to look at a complex set of overlapping issues. By looking at many issues simultaneously, decision makers can avoid the mistake of disproportionately weighting the solution to one problem over another without balancing the needs and possible solutions for both. Throughout the work of developing *Enhancing and Caring for the Laguna* participants were challenged to think about this complexity at every decision point. Thus, in the end, the goals, objectives, and recommendations which form the core of this work, was strengthened by considering things in this place-based fashion: by simultaneously looking at the Laguna as an economic engine, as an agricultural work horse, as a cultural and historical attraction, and as an ecological hotspot, the goals and objectives for the Laguna de Santa Rosa have been well received and broadly supported by the area's diverse community of stakeholders.