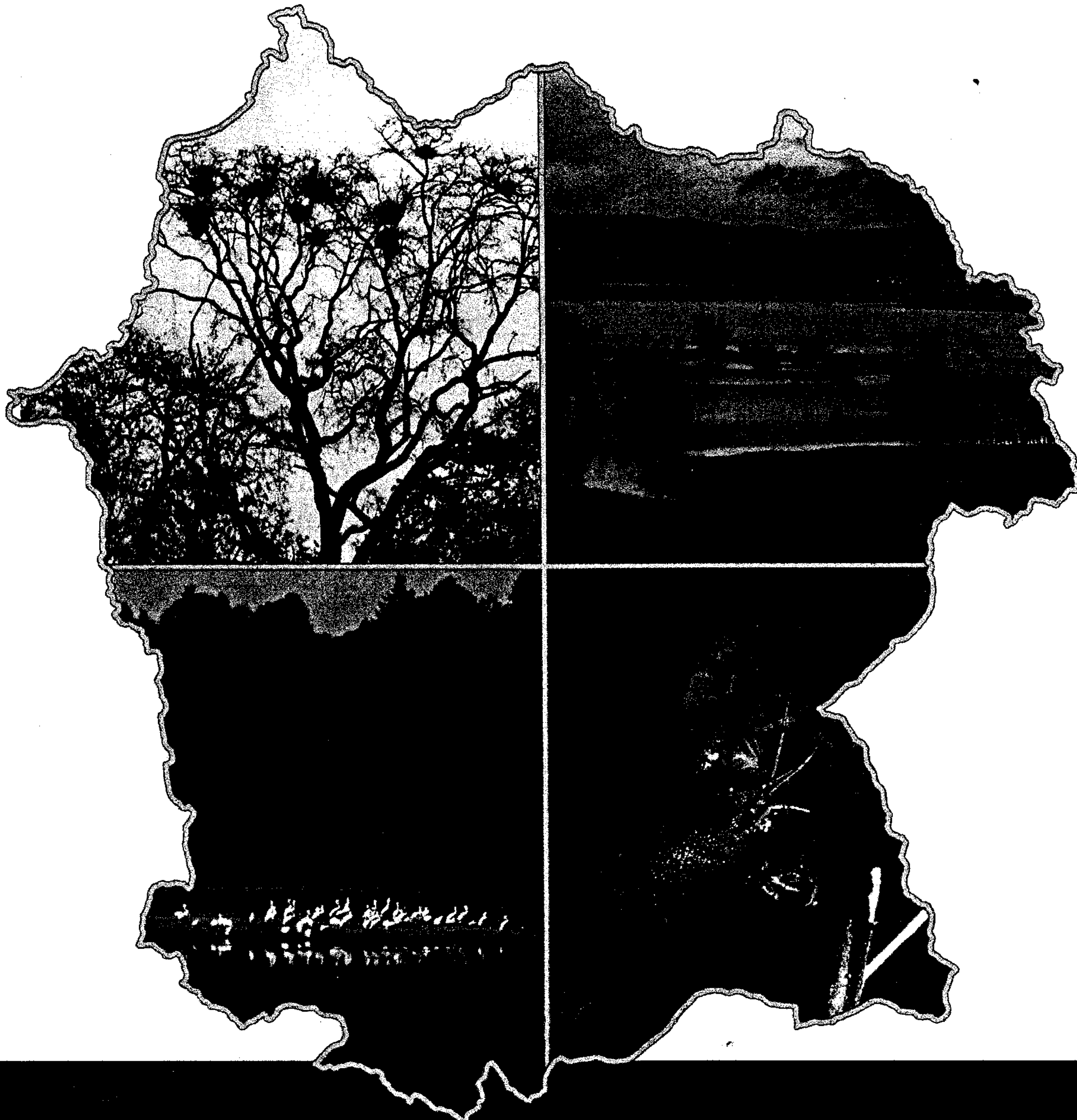
The Altered Laguna

A Conceptual Model for Watershed Stewardship



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- Develop a suite of conceptual models to identify key factors and processes driving existing and future conditions within the basin with regard to hydrology and sedimentation, water quality, and ecosystem processes;
- Perform data gaps and uncertainties analysis to identify the information needed to complete an assessment and modeling analysis of the basin, including those assessments and tools needed for TMDL development;
- Develop model selection and development recommendations to ensure that the chosen approach addresses the needs of all of the modeling objectives;
- Prepare monitoring recommendations to provide a basis for data collection prioritization.

1.2 Role of conceptual models

In the highly complex Laguna de Santa Rosa watershed system, predictions are only possible by close examination of all system components. Our understanding of the linkages among these components is made tangible through a series of steps that progress from the conceptual model addressed in this report to dynamic modeling simulations in the near future:

- Conceptual models are developed to illustrate all system components and recognizes linkages between the initial drivers (stressors), the intermediate outcomes (response components or effects), and ultimate impacts (final outcomes or attributes);
- The conceptual models are developed in conjunction with a parallel process of identifying the important and relevant management questions and restoration priorities to be addressed;
- Preliminary restoration objectives and key uncertainties are then described, and data gaps and information needs are clarified and monitoring recommendations are developed;
- The conceptual models are used to guide selection of dynamic/fully automated simulation models that are capable of simulating all of the key components and linkages that have been identified;
- The monitoring plan is then implemented to address key uncertainties, data gaps, and to provide the dynamic model with the information necessary to simulate various management scenarios;
- The dynamic models are then calibrated to achieve an adequate level of predictability of outcomes according to specific input parameters. Model calibration is achieved when the model can successfully replicate a quality assured monitoring database of the targeted system (e.g., the Laguna);
- This final step ensures that the watershed stewards can use the model to explore various management options and that the model outcome is reasonably realistic and dependable.

3.5 Biological diversity

Management questions related to biological diversity are discussed here, together with the key uncertainties and data gaps that limit these discussions. To the extent possible, working hypotheses are provided for each management question.

Question 3.5.1 What are the ecosystem engineers of the Laguna, and what are their 'roles?' What are the highest priority habitat restoration targets for improving water quality? How would enhanced riparian habitat conditions improve water quality and the status of beneficial uses? How does habitat degradation influence beneficial uses, water quality, flooding capacity, water supply?

Riparian zones

Trees in riparian buffer zones can be viewed as "ecosystem engineers," as they fundamentally change ecosystem function. Riparian zones could thus be viewed as 'keystone' communities. Areas where historical riparian vegetation have been lost are sure indicators of habitat loss/degradation, negatively affecting the entire associated aquatic and terrestrial communities. Terrestrial streamside communities are mainly impacted through the loss of cover, foraging and nesting habitat (Pearson and Manuwal 2001). Stream habitat degradation could be in the form of increased run-off and stream bank erosion, lack of shade along stream banks causing increased water temperatures, and loss of fish cover or spawning habitat. Lack of riparian vegetation may also allow adjacent livestock to enter the water, causing bank erosion, degrading the stream bottom through trampling and the introduction of increased nutrients into the stream via direct and indirect input of livestock excrement.

The loss or degradation of vegetation along streams also reduces the effectiveness of riparian buffers to improve water quality through processing and removal of excess anthropogenic nitrogen from surface and ground waters. To maintain maximum buffer effectiveness, buffer integrity should be protected against soil compaction, loss of vegetation, and stream incision (Mayer et al 2006). Restoring degraded riparian zones, and stream channels may improve nitrogen removal capacity of the stream system, making riparian buffers a 'best management practice' (Mayer et al 2006). While there is not one generic riparian corridor width to keep water clean, stabilize banks, protect wildlife, and satisfy human demands, generally the larger the width of vegetation, the better the impact on ecosystem services and biodiversity (Kreitinger & Gardali 2007, Semlitsch and Bodie 2003, Pearson and Manuwal 2001).

Invasive *Ludwigia* sp.

Invasive exotic plants can also act as 'ecosystem engineers,' negatively impacting the ecosystem (Crooks 2002). As exotic invasive plants, such as invasive *Ludwigia* sp., increasingly take hold in native plant communities, they threaten native biodiversity by changing the native vegetation structural diversity, often completely 'taking over,' not only out-competing native plants and establishing an extensive and expanding mono-culture, but in the process permanently changing the habitat structure and function. This process so fundamentally changes the original native ecosystem, causing the local extinction of organisms tightly linked to the original community structure and function (National Invasive Species Council 2001). A large proportion of noxious invasive plants were brought to their new range by humans and initially established in disturbed sites (Mack et al 2000).

Key Uncertainties and Data Gaps

Riparian zones

Extant riparian areas in the Laguna de Santa Rosa have been mapped in the lower watershed via aerial photo interpretation in 2000 (Laguna de Santa Rosa: Resource Atlas and Protection Plan 2000), and modeled in 2006 on a watershed scale in Enhancing and Caring for the Laguna (Vol. II, Plate 2). In order to expand on these baseline efforts, the Laguna de Santa Rosa Foundation is currently engaged in a comprehensive mapping effort of the entire watershed using aerial photography. This effort aims to address current data gaps in the watershed.

Invasive *Ludwigia* sp.

Some of the factors influencing invasive *Ludwigia* sp. growth may include: changes in hydrology of the Laguna, sedimentation and siltation of channels and streams, and nutrient loads in sediment and/or water column. There are several pathways for the capture of nutrients by invasive *Ludwigia* sp. via trimorphic roots: floating nodes on the gas-filled, rhizomatous shoots are able to absorb nutrient from the water column directly, while subsurface roots take up nutrients from the sediment. Studies of the relative contribution of each pathway towards plant vigor have not been completed. Preliminary data from a completely randomized, full factorial growth experiment by USDA/ARS (Dr. Brenda Grewell, pers. comm.) suggest that soil nutrient loadings may be more significant in affecting early invasive *Ludwigia* sp. growth (highly significant across all response variables) than nutrients in the water column. Continuation of this USDA/ARS research program will likely shed more conclusive light on this question in the near future.

At this time the specific relationship between nutrient loadings, habitat factors and invasive *Ludwigia* sp. growth is still unclear, and no conclusive inferences can be drawn from currently available data.

Hypotheses

Relationship of terrestrial and aquatic fauna to riparian habitat loss and fragmentation. Riparian zones provide foraging and nesting habitat for migratory and resident birds and territory and corridors for terrestrial vertebrates and invertebrates. They further provide stream bank structure and reduce water temperature for aquatic fauna and flora. The size and complexity of the riparian vegetation is positively correlated with the amount of terrestrial and aquatic biodiversity.