DRAFT STAFF REPORT

RIPARIAN SYSTEMS IN THE NORTH BAY PLANNING AREA

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The North Bay Wetlands and Agriculture Protection Plan

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FOREWORD

The North Bay Wetlands and Agriculture Protection Program is a voluntary partnership between the San Francisco Bay Conservation and Development Commission (BCDC) and the eight local governments in the San Pablo Bay subregion of the San Francisco Bay area—Napa, Marin, Solano, and Sonoma Counties, and the Cities of American Canyon, Novato, San Rafael, and Vallejo. The approximately 110,000-acre North Bay planning area includes portions of those four cities as well as portions of northern Marin County, southern Sonoma County, southern Napa County, and eastern Solano County. Beginning in Marin County, the planning area is bounded generally by the north bank of Gallinas Creek and the San Pablo Bay shoreline to the south, Highway 101 to the west, Highways 116, 121 and 12 to the north, and Highway 29 to the east, terminating at the Carquinez Strait (see Figure 1).

The purpose of the North Bay Wetlands and Agriculture Protection Program is to: (1) provide local governments with the tools and information needed to ensure the protection, enhancement and restoration of the North Bay wetlands; (2) protect agriculture; (3) allow compatible uses to continue, such as recreation and public education, that are consistent with wetlands and agricultural values and functions; and (4) guide incompatible uses to other appropriate locations. Thus, the program will help local governments protect their wetlands and agricultural lands, increase opportunities for wetlands enhancement and restoration, and identify uses that are consistent with wetland ecological values.

To achieve this purpose, the Steering Committee will develop a North Bay Wetlands and Agriculture Protection Plan. The Plan will recommend a range of policy options that each city and county can use to protect its wetlands. Each city and county can use these options as it sees fit.

This report on riparian corridors in the North Bay planning area was prepared by the BCDC staff. The staff greatly appriciates the review and helpful suggestions of Joan Florsheim and Jennifer Vick of Philip Williams & Associates, consultants in hydrology. The report is one of a series of planning background reports prepared for the North Bay Wetlands Protection Plan Steering Committee, composed of representatives of each of the local governments in the San Pablo Bay Subregion and BCDC. Reports completed to date include North Bay Land Use and Public Ownership, Wetlands in the North Bay Planning Area, Agriculture in the North Bay Planning Area, and Polluted Runoff in the North Bay Planning Area. The reports will provide information for the Steering Committee to help it prepare the North Bay Wetlands Protection Plan recommendations. The reports will provide information for the Steering Committee to help it prepare the North Bay Wetlands and Agriculture Protection Plan.

Figure 1

San Francisco Bay Conservation and Development Commission

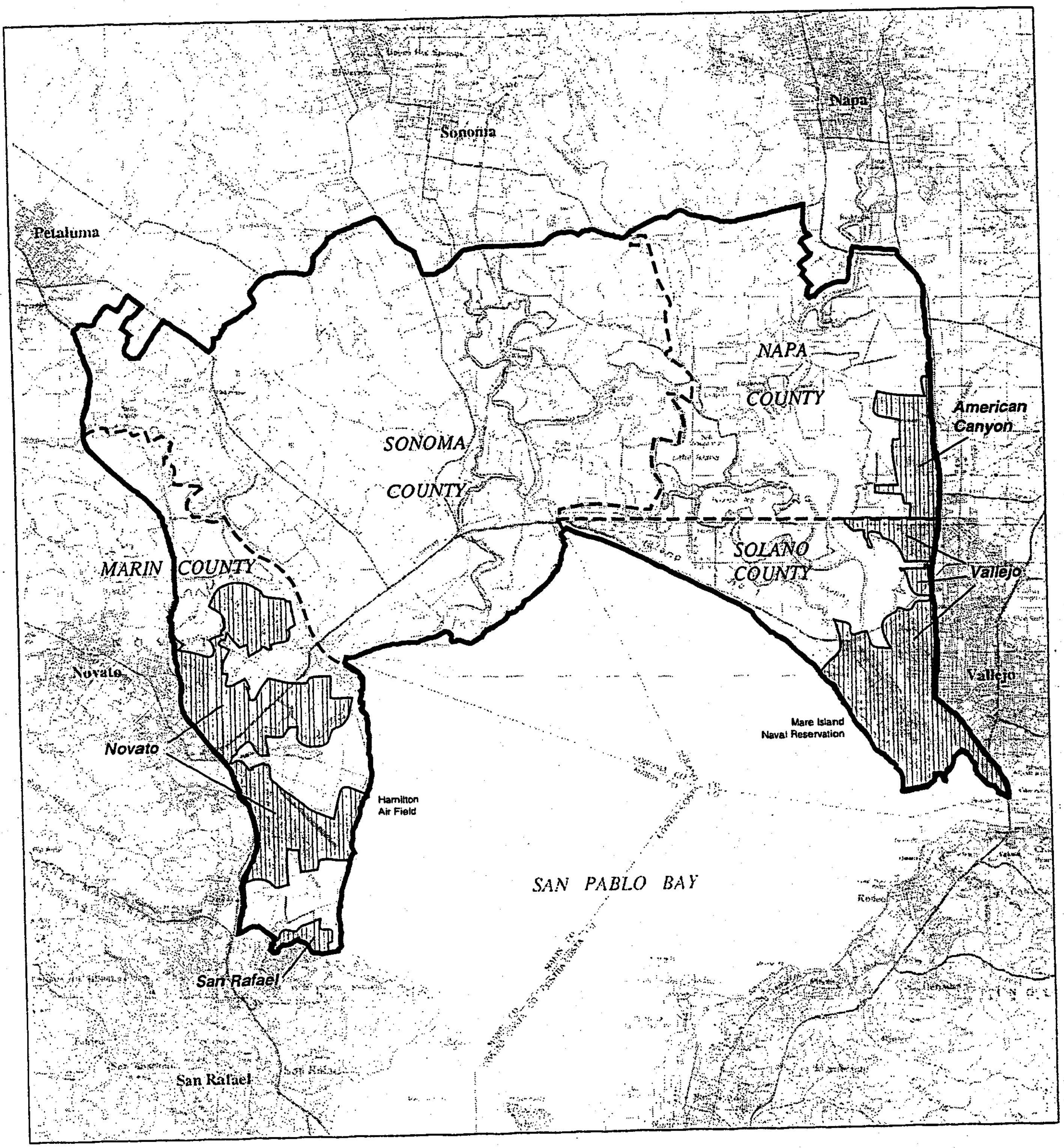
SOURCE: U.S.G.S., 1980; BCDC

North Bay Wetlands and Agriculture Protection Plan Study Area

Study Area Boundary

County Boundary

Portion of City within Study Area



CHAPTER 1

INTRODUCTION

Most rivers and creeks in the North Bay watershed drain directly into the North Bay wetlands (Figures 2 and 3). Because the rivers and streams in the North Bay directly feed into the wetlands, delivering water and nutrients, these waterbodies can either adversely affect the wetlands or nurture them. For example, healthy river and creek habitats, also called riparian corridors (lands of, on or relating to the banks of a natural course of water) can remove pollutants from the water, prevent erosion, and support wildlife habitat in their own right. However, if plants along the creek bank are removed, the creek will no longer be able to take out the pollutants, and will deliver toxic water to the wetlands. Furthermore, without the vegetation, the creek may erode, dumping soil (or sediment) down into the wetlands and smothering them. In other words, in order to have healthy, functioning wetlands, we need healthy, functioning rivers and creeks.

This report describes river and creek habitats and their function in the North Bay and explains why they are important to wetlands. It also looks at river protection tools and current local protection efforts. A separate background report, Polluted Runoff in the North Bay, addresses water quality issues in greater detail.

Report Structure

Chapter 2, Riparian Corridors in the North Bay, describes the relationship of riparian corridors to wetlands protection and the importance of riparian corridors.

Chapter 3, Riparian Issues, provides an overview of the North Bay river conditions, and describes the threats to the North Bay rivers. The chapter also emphasizes local solutions to these problems. It also touches on other riparian issues, such as permit problems, restoration, and multi-objective management.

Chapter 4, Preliminary Findings and Policies, provides the preliminary findings and policies to help keep riparian corridors functioning, thus protecting the wetlands.

Appendix A, Buffer Size and Design, provides technical information regarding buffer size, design, and implementation.

Appendix B, Example Riparian Ordinance

Appendix C, Environmental Flood Control Guidelines, discusses measures flood control agencies and local governments can use to ensure that their flood efforts help, rather than hurt, the creeks.

Appendix D, Exotic Invasive Plants in California.

CHAPTER 2

RIVER AND CREEK HABITATS IN THE NORTH BAY

Rivers and creeks often support plants and animals on their banks and on adjacent uplands. These habitats are called "riparian corridors,[1]" and can occur along intermittent streams, perennial streams or rivers, and tidally influenced channels. Healthy riparian areas are important for downstream wetlands, because they help deliver food and water to the wetlands. Damaged rivers and creeks can hurt the wetlands by smothering them with too much sediment, or serving as a conduit for pollutants washed or dumped into the waterways upstream. Riparian corridors are also important aquatic and terrestrial wildlife habitats, providing cover and food sources, keeping the streams cool for aquatic life by providing shade, filtering pollutants from the water, minimizing erosion, stabilizing creek banks, moderating floods, and recharging groundwater basins.

This chapter describes the critical connection between rivers and wetlands, and describes the important functions riparian corridors provide for humans and both aquatic and terrestrial animal species. It also describes the types of riparian habitat found within the study area, and a general impression of the overall condition of the North Bay rivers and creeks.

How Rivers Affect Wetlands

North Bay rivers, streams and creeks directly affect the health of North Bay wetlands and San Pablo Bay—either positively or negatively. Most rivers and creeks in the North Bay eventually drain into the wetlands, delivering nutrients, pollutants, and sediment in the process. If a creek is healthy, it can filter out pollutants and trap soils, thus protecting water quality and habitats downstream. Riparian floodplains can also store flood water and reduce peak flows downstream, thus keeping the floods from overwhelming the wetlands below. Furthermore, when the plants in the rivers and creeks die and decompose, or drop leaves, the plants become nutrients for the downstream wetlands. Finally, some wetland aquatic and terrestrial species depend upon riparian corridors during certain phases of their life cycles. In other words, healthy, productive wetlands require healthy, functioning rivers and creeks.

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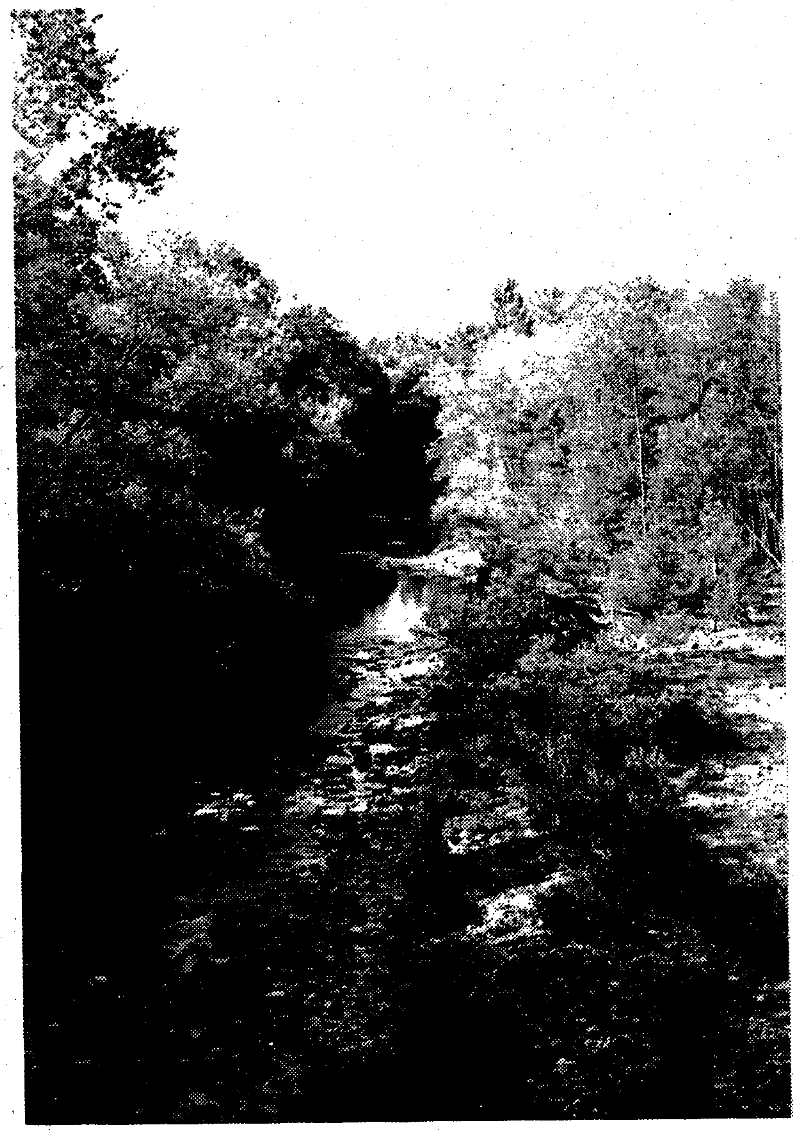
[1] Scientists define riparian corridors in a somewhat more technical manner. Warner describes riparian as "pertaining to the banks and other adjacent terrestrial (as opposed to aquatic) environs of freshwater bodies, watercourses, estuaries, and surface-emergent aquifers (springs, seeps, oases), whose transported freshwaters provide soil moisture sufficiently in excess of that otherwise available through local precipitation to potentially support growth of mesic vegetation." (Warner, 1994).

Figure 2

Example of a North Bay Riparian Corridor



Just as healthy streams and rivers help protect and nurture wetlands, damaged rivers can adversely impact the wetlands. For example, if vegetation is removed from a creek bank, the creek can erode, and the resulting sediment can cover the downstream wetlands and smother the plants and animals living in the wetlands. Moreover, increase in the elevation of wetland areas can eliminate the wetlands causing them to evolve into upland habitat. Without riparian vegetation, the creek also loses its ability to filter or absorb pollutants including sediment washed into steams under the natural erosion process, thus making the water delivered to the wetlands more harmful to the wetland system. As another example, if motor oil is released into a stormdrain, that motor oil may eventually flow to a river or creek, and then to the downstream wetlands, where the oil can destroy wildlife habitat and kill fish.

Table A

How Rivers and Creeks Protect Downstream Wetlands

River Functions		Benefits to Downstream Wetlands[2]
Habitat and Food for Wildlife	⟹	Provides food for downstream wetlands, and habitat connections for species that use wetlands and rivers
Regulates Temperature	⟹	Protects fish habitat
Protects Water Quality	⟹	Prevents pollutants from reaching wetlands
Minimizes Erosion	⟹	Prevents sediment from filling spawning and feeding areas
Stores Floodwaters	⟹	Protects wetlands against excessively fast floodwaters
Recharges Groundwater	⟹	Can maintain level of water tables in wetlands

[2] This table provides examples of benefits to downstream wetlands, it is not intended to be a comprehensive list.

Why River and Creek Habitats are Important (Functions and Values of Riparian Corridors)

1. **Habitat And Food For Wildlife.** Rivers and creeks provide important habitat for many kinds of aquatic life and terrestrial wildlife, including fish, amphibians, migrating and resident birds, and mammals. Roots, fallen logs, and overhanging branches create diverse habitats and cover for fish and aquatic insects. Leaves and insects droppings from overhanging vegetation also contribute food and nutrients to the aquatic system. Some species, such as hole-nesting or bark-gleaning birds, are completely dependent on rivers and creeks for their survival (San Francisco Estuary Project #1991a). Some species use riparian habitat as corridors for travel between upland and lowland habitats. Riparian corridors are very important habitat for some types of migratory birds as well.

Rivers and creeks tend to support very diverse kinds of wildlife, in part because they provide all of the essential needs for many species, including food, water, and cover. Furthermore, the multiple layers of vegetation often found in creeks result in complex microhabitats, which encourages a greater diversity of species.

Many California species, including endangered or threatened species, depend heavily on these riparian areas. For example, of the 47 amphibian species in California, 40 depend on riparian areas. Forty–six percent of land bird species listed as endangered, threatened or of special concern need riparian habitat, and over 135 species of California birds depend entirely on riparian habitats. One hundred and thirty–three types of mammals are also limited to or dependent on riparian wetlands (California Department of Fish and Game, 1994).

Riparian habitats in the North Bay provide habitat for the California freshwater shrimp (an endangered species), as well as nursery and spawning habitat for trout, salmon, steelhead, and other fish (Partnership for the San Pablo Baylands, 1996). The Napa River, for example, provides habitat for numerous birds and aquatic life, including several endangered species, such as the Clapper Rail and the Salt Marsh Harvest Mouse (Lewis Environmental Services, Inc., and Wetlands Research Associates, Inc., 1992). Historically, the Petaluma River once supported large runs of steelhead and Chinook salmon; however, these salmon runs are almost extinct today, due to the removal of native vegetation, polluted stormwater runoff, overdraft of groundwater, and too much fine sediments transported in the water body (San Francisco Regional Water Quality Control Board, no date).

2. **Temperature Regulation.** Overhanging trees and streamside vegetation shade streams, keeping the water from getting too hot. Many fish species, such as trout and salmon, depend on this cool water for their survival (in part because cool water has more dissolved oxygen than warm

water (Labaree, 1992)). Some small organisms on which larger fish feed, such as phytoplankton and aquatic insects, also need cooler water temperatures to survive. Therefore, it is important that trees and other vegetation that shade streams be maintained.

3. **Water Quality Protection.** Riparian vegetation can protect the stream's and wetland's water quality by filtering out toxins, such as oils, herbicides, and pesticides, excess nutrients, and excess sediments; all which can harm water habitats. Vegetation can trap toxins, nutrients, and sediments before they reach the stream. Furthermore, the vegetation or stream microorganisms can consume many of the toxins or nutrients in surface or soil waters. Thus, the river and creek habitats protect the downstream tidal wetlands by cleansing the water. Protecting water quality is important not only for ecosystem health, but for uses related to agriculture and some commercial activity and, potentially, for protecting drinking water. The effectiveness of filtration can depend on how wide the riparian area is, what kind and how much vegetation exists, the slope of the creek banks and surrounding land, the amount of nutrients or toxins present, and other factors.

Stream and creek vegetation reduces soil and sediment in streams by slowing the flow of surface and ground water to the stream, and by trapping eroding soils from adjacent land. By trapping excess sediment, the creeks help protect the wetlands from filling in (too much sediment can also cover plants, clog fish and amphibian gills, and raise the elevation of wetlands to the point that they convert to upland).

4. **Erosion Control and Channel Stability.** Streamside vegetation can help minimize erosion and stabilize creek banks. The complex root system of trees and shrubs stabilizes soil and protects against the cutting action of running water. In other words, healthy, vegetated rivers can minimize erosion and sedimentation (erosion being the loss of soil; sedimentation being the build up of soil) and stabilize banks.

Sedimentation can build up the bed of a creek and reduce the capacity of the creek channel to carry water. Excess sediment can also convert wetlands to uplands, fill marshes, destroy wetlands habitats, smother spawning and feeding areas; smother plants and animals that live in the water; and impact the ability of animals seeing (and capturing) their prey. Because pollutants often attach to soil, sediment can transport pollutants. Furthermore, sediment can also cause a variety of economic problems, (such as requiring the need for costly dredging). By minimizing erosion, riparian vegetation keeps excess sediment from reaching streams and consequentially wetlands. Furthermore, by stabilizing the banks, the riparian vegetation also helps prevent property and crop damage.

5. **Flood Storage.** River and creek floodplains can store flood waters. Riparian vegetation slows the flow of water with physical resistance. Thus, a healthy riparian corridor can moderate the force of floods, which in turn can help protect downstream wetland areas. Slowing a stream's

velocity allows more of the water to seep into the soil, which is then slowly released into the atmosphere through evaporation or through transpiration from plants, or slowly discharged from ground water. When faced with flooding problems, the voters in Napa County decided to take advantage of the river's natural flood control abilities, and recreate the natural floodplain instead of channelizing it.

6. **Ground Water Recharge.** Fresh water is highly valued in California, particularly by farmers whose livelihoods depend upon an ample supply. Riparian floodplains and vegetation slow runoff and temporarily store water, which allows extra time for floodwaters to enter the groundwater system. In other words, healthy rivers and creeks help recharge groundwater basins. In general, ground water recharge can help protect wetlands by maintaining the level of the water table in the wetlands. Groundwater can also provide base flow or dry season flow into the rivers and wetlands in some areas.

7. **Economic Value.** Evidence shows that the scenic value of a healthy river or creek can mean increased property values for property owners and communities (City of San Jose, 1994). Furthermore, since a functioning riparian system supports greater numbers of high-value sport fishes, those that supply goods and services to sport as well as commercial fishermen also reap economic benefits.

8. **Recreation.** A healthy riparian corridor enhances recreational values along streams, such as fishing, boating, wildlife viewing, and hiking. Outdoor enthusiasts especially tend to appreciate the value of healthy, functioning rivers and streams.

Summary

Rivers and streams often support plants and animals on their banks and on adjacent uplands. These habitats are called "riparian zones." Vegetation in riparian corridors provide cover and sources of food for wildlife, keep streams cool by providing shade, filter pollutants from the water, stabilize creek banks, minimize erosion, moderate flood flows, and recharge groundwater basins. Because these rivers and creeks drain to the downstream wetlands, healthy rivers and streams are key to protecting wetlands.

CHAPTER 3

RIPARIAN CORRIDOR ISSUES

This chapter briefly examines the general condition of North Bay rivers and principal streams, and then looks at the potential threats to these water bodies (such as development and excessive erosion). For each threat, examples of local solutions to these problems are identified, such as voluntary watershed management plans, streamside protection ordinances, and establishment of streamside buffers. This chapter also touches on other riparian-related issues, such as permitting issues for agricultural uses.

Overview of River Conditions

Functioning rivers, as discussed in Chapter 2, are vital to healthy wetlands. How well, then, are the North Bay rivers functioning? The answer varies greatly, in part because of the difference in health and quality among different rivers, and also because different institutions and individuals assess health differently. For example, a recent report noted that Miller Creek in Marin County, Petaluma River, Huichica Creek in Napa County, and the Napa River have high ecological integrity[1]—in other words, these drainages contain high-value wildlife resources (Estuary, June 1997). At the same time, the same water bodies are considered "impaired[2]" by the San Francisco Bay Regional Water Quality Board (See Table B) because of pollution, excess sediment, and other water quality reasons.

In general, no pristine waterways exist in the North Bay watershed. All waterways have been impacted by human activity, either directly through modifications of the channel and adjacent land uses, or indirectly by activities upstream that impair water quality and flow. Furthermore, all of the riparian habitat corridors passing from freshwater habitat to tidal marsh are fragmented by roads and other kinds of development. Overall, the rivers in the North Bay share a number of problems, including erosion and sedimentation, flooding, high water temperature, habitat degradation, reduced freshwater flows, and polluted water. In addition, because of on-going upland development in the watershed, and more intensive agricultural uses (for example, the conversion of grazed lands to vineyards), these problems have increased.

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[1] The report measured ecological integrity using criteria such as diversity and abundance of native fishes and amphibians, flow patterns, habitat conditions, arrangement, and connectivity.

[2] "Impaired" is defined by the Regional Water Quality Control Board as a water body unable to support the beneficial uses designated by the Board.

Table B

Rivers or Creeks Considered Impaired by the Regional Water Quality Control Board
(Adapted from the San Francisco Bay Regional Water Quality Control Board, 1994)

River or Creek	Acres Impaired	Problem	Source
Huichica Creek	Unknown	Hillside Development for Vineyards Threat of damage to fish spawning areas	Point sources and polluted runoff
Napa River	40	Excess nutrients/algae Too much sediment Degraded fish habitat	Point sources and polluted runoff
Petaluma River	20	Excess nutrients/algae Too much sediment Degraded fish habitat	Point sources and polluted runoff
San Antonio Creek	Unknown	Excess nutrients/algae	Polluted runoff
Sonoma Creek	14	Excess nutrients/algae Excess coliform	Polluted runoff

Threats to Riparian Systems

Everything from pumping too much groundwater to dumping used motor oil down a stormdrain can harm a river or creek (and consequently downstream wetlands). Threats to a creek from urban areas, such as the land development process and residential landscaping maintenance practices, can be quite different from problems in rural areas (such as removal of vegetation to protect crops). However, we can broadly group threats to river health into seven major activities or problems: (1) removing riparian vegetation; (2) adjacent land use practices; (3) upstream and upland development; (4) invasive exotic vegetation; (5) polluted runoff; (6) erosion and sedimentation; and (7) changes to water patterns (or hydromodification). These seven issues are often interconnected. This section briefly describes these problems and looks at current North Bay solutions (summarized in Table C). Furthermore, Table D summarizes protection measures at the city and county level.

Table C

Riparian Problems, Effects and Solutions

Riparian Problem	What Causes It?	How Does It Affect Wetlands? (examples)	Examples of Current North Bay Solutions
Removal of riparian vegetation	Development, landscaping, crop protection, grazing, other	Destroys food sources for wildlife; allows more pollutants to enter wetlands	Voluntary stewardship; general plan policies to restrict removal; studies of Pierce's disease
Adjacent activities	Domestic pets, lighting, noise, trails, landscaping, other	Increases pollution of wetlands; damages wildlife habitat; increases erosion	Voluntary watershed plans, buffers and setbacks, riparian zones, development standards
Development	Development replaces soil with hard (impervious) surfaces	More pollution of wetlands; too much sediment (smothering of wetlands)	Construction best management practices, erosion or water quality ordinances, design standards for developments
Invasive vegetation	Plants such as Arundo donax	Promotes flooding	Outreach efforts, voluntary eradication projects, general plan policies, Team Arundo del Norte
Polluted runoff	Hard surfaces, gardening chemicals, pet wastes, other	Degrades water quality, thus harming fish and wildlife	Voluntary watershed plans, water quality ordinances, pollution prevention programs
Erosion/sedimentation	Urbanization, agricultural activities, trails, other	Can destroy spawning habitat and physically smother wetlands; can also degrade water quality	Technical assistance for farmers (such as ranch plans, vineyard management manuals, etc), best management practices, site design techniques, erosion and water quality ordinances
Changes in water patterns (hydromodification)	Cutting and filling slopes, flood control, water diversion, channelizing rivers, creating hard surfaces, other	Can directly damage wetlands through filling and dredging; can also increase water pollution in wetlands	Ordinances, minimizing hydromodification through site design practices, instituting creek-friendly flood control (such as non-structural flood control projects)

Table D

City and County Riparian Protection Measures

Local Government Riparian Protection Measures	Jurisdiction: Unincorporated County of Marin	City of Novato	City of San Rafael	Unincorporated County of Napa	City of American Canyon	Unincorporated County of Solano	City of Vallejo	Unincorporated County of Sonoma
Goal to protect riparian corridors	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Requirement to minimize impacts	Yes	Yes	Yes		Yes			Yes
Restrict removal of vegetation	Yes	Yes	Yes	Yes	Napa County Flood Control and Water Dist.; Vallejo Sanitation and Flood Control Dist. (VSFCD)	Yes	Yes, through VSFCD	Yes
Buffer required	Yes	Watercourse Protection Overlay Zone can serve as a buffer	Yes	Yes	Yes	Not formally, but follows Dept. of Fish & Game recs.		Yes, in Biotic Resources zone
If yes, minimum size?	50 - 100'	up to 50'	25-100'	35-150'	100'			50-100'
Design standards		As goal			Yes			
Mitigation requirements	Yes	Yes	Yes	Yes	Yes		Yes	
Riparian zoning		Watercourse Protection Overlay Zone (not yet completed)	Wetlands Overlay zone includes riparian areas		Goal to create Hillside Preservation & Riparian Corridor Zone			Biotic Resources Combining District
Riparian ordinance	Watercourse ordinance	Watercourse Protection Overlay Zone (not yet completed)	Creeks and Other Watercourses	Conservation Regs; Floodplain Mgmt.; Riparian Ordinance	Conservation Regulations; Floodplain Mgmt. & Riparian Ordinance			Ordinance #1108, Ordinance #3836R
Require permit for modifications to watercourse	Yes	Yes	Yes	Yes	Yes	Yes, through VSFCD	Yes, through VSFCD	Yes
Land use restrictions	Yes	Yes	Yes	Yes	Yes			Yes
If yes, examples?	Structural improvements & motorized recreational vehicles prohibited, among other uses	On parcels partially within zone, uses permitted only if uses on rest of parcel would have a more adverse effect on water quality.	Only uses allowed are construction and maintenance of water-related structures	Allows maintenance of agricultural crops, development of water resources, and other uses	Research, passive recreation allowed, among other similar uses			Restricts agricultural uses closer than 25-50' from top of bank; prohibits roads, structures, utility lines
Policy to encourage riparian restoration	Yes	Yes	Yes		Yes			
Policy to discourage invasive vegetation	Yes	Yes	Yes		Yes			Yes
Policy to ensure public access is compatible with riparian protection	Yes	Yes	Yes	Yes		Yes		
Other	General plan has streamside conservation zones; policies encourage stream mgmt. for fish	Creeks designated as open space in General Plan. New development must restore previously degraded areas, where feasible	Many of the above policies would apply only if the riparian area can meet the Corps' definition of a wetland	Encourages fishery and wildlife habitat management plans	Projects in riparian corridors must undertake a pre-CEQA environmental assessment			Encourages fishery management plans

1. Removal Of Riparian Vegetation

a. **Problem.** In urban areas, riparian vegetation may be removed for development, for residential landscaping, or for other reasons. In rural areas, riparian vegetation may be removed, for example, as part of the crop preparation activities or due to grazing. Vegetation removal directly damages the riparian ecosystem. For example, vegetation removal destroys important habitat and food sources for wildlife; reduces shade (which raises water temperature and harms certain fish species); reduces groundwater recharge; and destabilizes streambanks (resulting in greater erosion). Furthermore, without its vegetation, the river loses its ability to slow flood waters and retain soil and pollutants (in other words, stronger floods and higher concentrations of pollutants are passed downstream). Thus, removing riparian vegetation harms both the river ecosystem and the downstream wetlands.

Riparian vegetation removal happens throughout the planning area, in the drainage basins of the Petaluma River, Napa River, and Sonoma Creek. For example, development and agricultural activities in Sonoma Creek have removed vegetation (Sonoma Creek Watershed Enhancement Plan, 1997). In the North Bay, farmers have also recently cleared away riparian vegetation in order to protect their vineyards from plant disease. Riparian vegetation in the North Bay can host a blue-green sharpshooter that causes Pierce's disease, which damages vineyards. Some farmers remove this vegetation in attempts to preserve their vineyards. However, studies in the North Bay are trying to learn how to manage riparian habitat while controlling Pierce's disease.

b. **Solutions.** North Bay communities use many tools to prevent vegetation removal, including voluntary watershed management plans, technical assistance for farmers, buffer and riparian ordinances, and general plan policies. For example, Napa County's flood control ordinance specifies in detail what riparian vegetation removal is allowed in riparian zones (for example, one native tree eighteen inches diameter breast height per one hundred feet of zone of each side of the floodplain). Some North Bay cities and counties also require mitigation for any necessary riparian vegetation removal at a 2:1 ratio. Streamside buffer requirements, discussed under #2 Adjacent Activities and in Appendix A, are a common way to prevent vegetation removal in the North Bay.

In rural areas, solutions tend to focus more on technical assistance and stewardship approaches. For example, the Resource Conservation Districts can help farmers voluntarily fence cattle away from the creek, thus protecting the vegetation (and water quality). As another example, the Marin County Countywide Plan (the County's General Plan) policies require project applicants to keep natural vegetation, and to minimize disturbance of vegetation. Furthermore, many North Bay groups, such as the Sonoma Ecology Center, work with landowners on voluntary revegetation and restoration projects.

North Bay communities will need to find ways to both combat Pierce's disease and protect riparian vegetation. A five-year study is now underway to discover solutions. Examples of possible solutions include selective removal of plants which harbor the pest (particularly non-native vegetation) and planting rows of conifers between creeks and vineyards (Fred Botti, pers. communication). When successful techniques are identified, the Department of Fish and Game (DFG) may work with interested farmers to develop a memorandum of understanding (MOU), so that individual farmers who are partners in the MOU agreement do not need to obtain permits to manage the riparian vegetation. This process would help streamline the regulatory process – an advantage to both landowners and DFG.

2. Adjacent Activities

a. **Problem.** Land uses, practices and activities next to a creek or steam can degrade riparian habitat. For example, in residential areas, installation of lawns and gardens can displace river vegetation and the application of nutrients and herbicides can lead to pollution of the stream. Inappropriate trails from the homes to the creek can trample sensitive vegetation and cause erosion. Furthermore, domestic pets such as dogs and cats can find their way to the stream, polluting water and harassing wildlife. In commercial or industrial areas, noise and light from nearby uses can disturb wildlife breeding and foraging. In rural areas, agricultural activities in or nearby a creek, such as grazing or discing, can remove or degrade riparian habitat.

Incompatible adjacent activities can happen despite a city or county's riparian protection policies. For example, staff members of the San Francisco Regional Water Quality Control Board have noticed new homes built with insufficient stream buffers, some directly on or over the waterbody, in spite of protective general plan policies in these jurisdictions (Dale Hopkins, pers. communication, Leslie Ferguson, pers. communication). These cases may be due to legal variances (for example, an oddly configured lot that has no room for a creek setback), or may be due to illegal activities.

Adjacent activities are a challenge throughout the watershed. For example, in Miller and Champlin Creeks, grazing near the creek has reduced the riparian vegetation. In Miller Creek this vegetation removal has likely contributed to flooding and erosion, scouring, and groundwater seepage (Liz Lewis, pers. comm). Adjacent industrial activities on Mare Island have contributed to water quality problems in the lower Napa River.

b. **Solutions.** North Bay communities work to make adjacent land uses and land use practices compatible in many ways. Local solutions include education, technical assistance, voluntary watershed plans, ordinances, land use restrictions, zoning, design standards, general plan policies, mitigation requirements, and more.

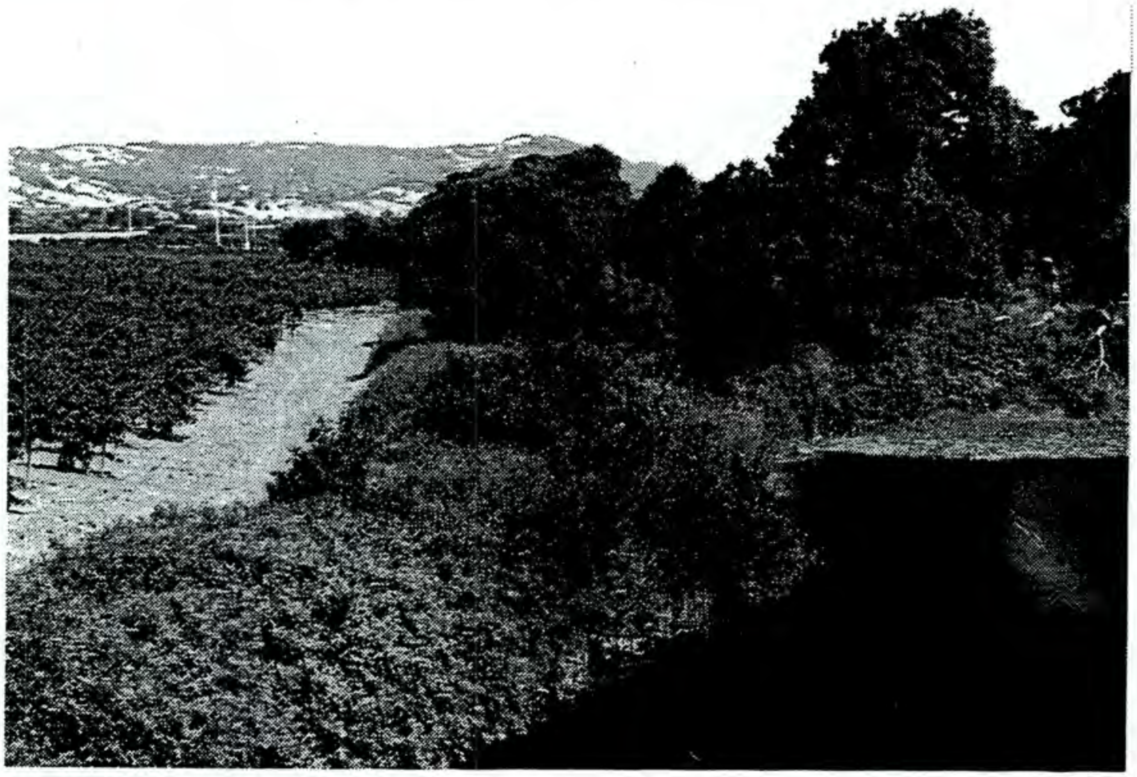
In rural areas these solutions tend to focus on education and voluntary stewardship. For example, the Napa Resource Conservation District (RCD) created a Napa River Watershed Owner's Manual, a voluntary integrated resource management plan designed to maintain a sustainable river ecosystem. Developed by the RCD with consensus from landowners, resource agencies, and other interested parties, this manual provides an integrated list of recommendations for landowners and government entities that will help maintain a sustainable resource base for the Napa River drainage basin. The recommended practices are implemented voluntarily by landowners, users and managers, with technical assistance from many organizations. The three guiding goals of the plan include establishing a sustainable river ecosystem, improving watershed water quality, and improving water quantity. Objectives to achieve these goals include promoting natural stream stabilization and contiguous habitats, increasing biological diversity and fish habitat, and encouraging land stewardship. Some of the recommendations focus on making the land uses and practices near the river as respective of the stream environment as possible.

Another local solution is the establishment of buffer areas along streams. Riparian buffers or creek setbacks can preserve wetlands and floodplains, help stabilize stream banks, reduce erosion and sedimentation, reduce the volume of runoff, reduce pollutant loads, provide recreation, protect wildlife and habitat, and increase property values, among other functions. Some buffers are implemented voluntarily by farmers or landowners seeking to protect their streambanks, farmlands and water quality for their crops. Buffers are also sometimes required by cities and counties through their land use planning and control authority. In North Bay cities and counties that require buffers, the minimum buffer size ranges from 25 feet to 150 feet. For many projects, the planning departments rely on recommendations by the Department of Fish and Game to determine appropriate buffer sizes.

Problems with buffers nationwide include poorly designed buffers and buffer destruction by new owners unaware of their purpose. For example, throughout the country, river buffers near homes are often removed and turned into lawns and other residential landscaping. Another buffer problem is failing to see buffers as a comprehensive system. For example, many local governments find themselves unprepared for changes in the buffer, such as storm damage, runoff cutting channels into the buffer, or people clearing out the buffer to plant a lawn. Nor do most local governments consider the buffer system during their general planning process or open space acquisition efforts. Furthermore, some landowners see buffers as an economic burden because it makes less land available for farming or development. For further discussion on buffer sizes, design, and implementation, refer to Appendix A.

Figure 3

Buffer Between Vineyard and Sonoma Creek



Other jurisdictions use zoning to protect riparian values. For example, Marin County has a stream and conservation zone, including the stream and banks to a width of 50 to 100 feet on both sides of the channel. Within the stream and creekside conservation zone, development proposals undergo site specific reviews to determine their compatibility with the streamside conservation area policies in the countywide plan. Certain land uses, such as trails and flood control projects, are permitted in these areas; and certain other land uses, such as livestock confinement and refuse dumping, are prohibited. Although not in use for San Pablo Bay rivers and creeks, Sonoma County's Biotic Resources district requires setbacks of 50-100 feet on both sides of the channel, prohibits structures, roads, utility lines, parking lots, lawns, grading, fill or excavation (with certain exceptions), specifies allowable uses in a streamside conservation area (such as permitted summer dams, grazing, road crossings, etc.), and restricts agricultural cultivation closer than 25 - 50 feet from the top of the bank within the study area.

In urbanizing areas, development standards are often an appropriate tool. As an example of development standards, the Draft General Plan Amendment Proposal, created by the first St. Vincent's/Silveira Advisory Committee, contains protections for Miller Creek. Although the proposed general plan amendment was not adopted, the noteworthy protections include encouraging the retention of natural vegetation in the buffer area; removing exotics and replanting with natives; minimizing disturbance of native vegetation; mitigating unavoidable vegetation removal at a 2:1 ratio whenever feasible; modifying natural channels for flood control in a manner that retains and protects riparian vegetation; maintaining adequate flood control capacity; restricting public access as per future environmental recommendations; siting trails at adequate distance from the creek to protect wildlife corridors; discouraging filling, grading, or alteration of the bed or banks; providing 100 foot buffers; allowing work in the buffer area only during the dry season (such work should provide sediment control); encouraging vegetation rather than fencing; and stipulating that ongoing, coordinated creek corridor resource management mechanisms shall be identified.

Another example of development standards can be found in the City of American Canyon's general plan.[3] The general plan contains several policies to preserve significant riparian habitats, including Policy 8.3.1, which requires that proposed developments in riparian habitats be evaluated to conform with various standards, such as avoiding significant impacts; retaining undeveloped buffer zones; preserving riparian habitat; providing a 100 foot protection zone from the edge of the tree, shrub, or herb canopy; incorporating habitat linkages; utilizing open space and conservation easements to protect sensitive species or their habitats; and requiring mitigation for diminished riparian habitat values (American Canyon General Plan, 1994).

Because streamside buffer areas are a tool most often used by cities and counties, particularly in developing areas, two streamside protection model ordinances are offered in Appendix B. The first model ordinance is more applicable to cities and urbanizing areas of counties. The second model ordinance is more applicable to rural areas of counties. One failing of many stream protection ordinances is they do not provide provisions for modification to stream channels and banks that would restore and maintain the stream and

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[3] Yet another good example is the City of San Jose Riparian Corridor Policy Study, which contains design guidelines for development that is respective of the stream environment.

provide for flood control. Both model ordinances in Appendix B have provisions allowing stream modification for flood control and stream hydraulic function and habitat restoration.

3. Upstream and Upland Development

a. **Problem.** Because of the way watersheds work, even uses far away from a creek can harm a riparian corridor. For example, development often replaces soil with hard (or impervious) surfaces such as concrete or asphalt. This means that less water recharges the groundwater basin, and more runs off into the stormdrains, streams, and eventually the wetlands. This extra water can contribute to flood problems and hurt the creeks and streams by eroding the stream bed and banks. Furthermore, the extra water often picks up pollutants from the ground, and washes them into the stormdrains, streams, and wetlands. Thus, by building hard surfaces, upland development can result in too much runoff, and pollution to the rivers and wetlands. Novato Creek, for example, is subject to sedimentation and erosion brought on by development.

b. **Solutions.** Local solutions include design standards for new development, erosion control and water quality ordinances and best management practices (BMPs), and other measures. Overall, these measures aim at minimizing erosion, limiting hard surfaces and controlling runoff. These tools are discussed further in the polluted runoff report.

4. Invasive Vegetation

a. **Problem.** Many California waterways are plagued by non-native, invasive plant species, such as giant reed (*Arundo donax*). Arundo chokes out native plants, promotes flooding, changes water patterns, and provides minimal wildlife habitat benefits for native species. *Arundo donax*, which is a problem in the upper reaches of Sonoma Creek, poses extreme threats to the biodiversity of the riparian habitat. Although Arundo is the most well-known invasive problem, other non-native, invasive plants cause problems throughout the Bay Area as well, such as Himalayan blackberry and German ivy. Appendix C provides a list of other invasive pest plants commonly found in riparian environments in California.

b. **Solutions.** Current North Bay solutions include general plan policies, outreach efforts, regulatory streamlining efforts, and development standards. For example, the City of San Rafael's Wetland Overlay District standards, which includes creeks, requires developers to use non-invasive landscaping. As another example, the Team Arundo del Norte, a group of nonprofit agencies and local government representatives, works to control Arundo by educating landscapers, landowners, and others. The Team also sponsors voluntary eradication efforts, working with interested landowners. The Team is also studying the best way to eradicate Arundo.[4], and is working to streamline the permit process to make it easier to eradicate Arundo.

Figure 4

Arundo donax in Sonoma Creek

5. Polluted Runoff

a. **Problem.** Polluted runoff, also called non-point source pollution, is pollution which comes from all sources besides "point" sources (that is, discernible, confined, and discrete discharge points such as the end of a pipe). When it rains, the rainwater flushes through the watershed, gathering pollutants on the ground (such as oil, sediment, detergents, pet wastes, etc.) and carries them to the stormdrains, streams and creeks, and ultimately to the wetlands. Development contributes to the problem by replacing soil with hard surfaces (such as asphalt and concrete) that limit the natural permeability of water into the ground, thus increasing the amount of runoff (and pollution) reaching the creeks and streams.

[4] These studies also look at the effects of herbicides on the streams.

Polluted runoff harms wildlife and humans alike. Runoff can contain so many pollutants and nutrients that it overtaxes the riparian vegetation's natural ability to filter and trap pollutants, and thus can seriously degrade the riparian and downstream wetland vegetation habitats. A separate background report discusses polluted runoff in detail.

b. **Solutions.** Local solutions to polluted runoff include education, technical assistance, design standards for new developments, best management practices, water quality ordinances, stormwater pollution prevention programs, and other measures. Solutions in rural areas tend to focus on technical assistance and voluntary stewardship. Polluted runoff solutions are discussed in more detail in the polluted runoff background report.

6. Erosion and Sedimentation

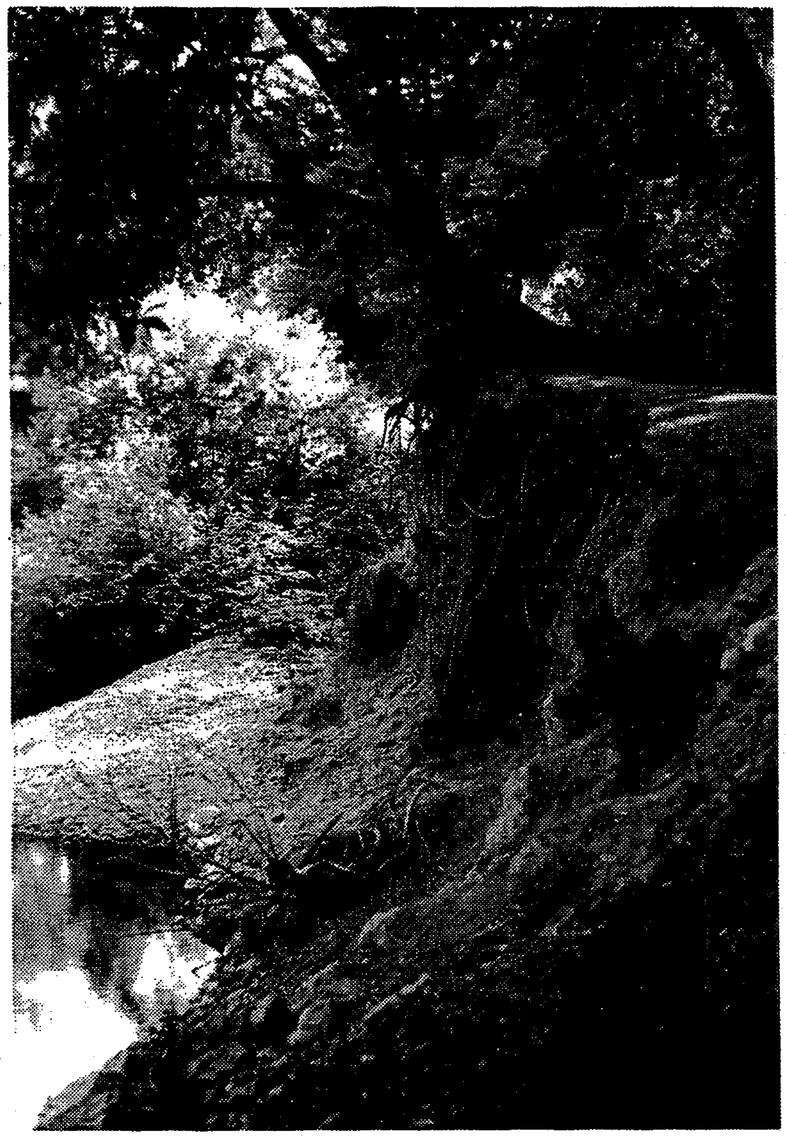
a. **Problem.** Many activities, such as plowing and discing for agriculture, overgrazing, road construction, urbanization, fires, quarrying, and simple recreational activities such as hiking and cycling, create siltation problems in the streams by disturbing the soil and changing natural runoff patterns. Too much sediment can cut off needed light for plants (thus affecting the food chain) and wipe out spawning habitat for certain fish species. Excess sediment can also physically smother wetland vegetation, converting the wetland habitat into upland habitat. Furthermore, sediment also can carry pollutants, so increased sediment can mean lower water quality.

Erosion and sedimentation are problems throughout the North Bay. For example, consider the Napa River Watershed, which drains 426 square miles from Calistoga to San Pablo Bay. Approximately 50 miles of Napa County streams are ranked as "severely" or "very severely" eroding, a condition resulting from too many hard surfaces, reduced groundwater infiltration, and the removal of riparian vegetation (San Francisco Regional Water Quality Control Board, 1992). Sediment comprises the majority of the pollutant loads in the river (Napa County Resource Conservation District, 1995). This sediment can come from agricultural sites, construction and hillside erosion. Much of the source of pollution is beyond the North Bay planning area. Other contributors to pollution include the removal of hillside and streamside vegetation and riverbank erosion upstream in the watershed. Sediment and accelerated erosion add to other water quality problems in the Napa River, such as too many nutrients and degraded fish habitat (San Francisco Regional Water Quality Control Board, 1992).

The San Francisco Regional Water Quality Control Board is very concerned about unregulated, sediment producing activities on hillside vineyards, and the effect of the sediment on the creeks and their tributaries (Bill Hurley, San Francisco Regional Water Quality Control Board, pers. comm.). However, the Southern Sonoma County Resource Conservation District is working closely with vineyard owners to reduce these impacts in Sonoma County, as is the Napa Resource Conservation District in Napa County. Sediment and erosion also appears to be making flood problems worse along the southern reaches of Sonoma Creek (flooding here is also caused partly by narrow channels and tidal action).

Figure 5

Erosion in Sonoma Creek



b. **Solutions.** Education, technical assistance, voluntary watershed plans, ordinances, best management practices, general plan policies, and other measures can be used to prevent erosion and sedimentation. For example, many of the North Bay cities and counties have erosion control or grading ordinances. In urbanizing areas, many of the cities and counties require best management practices to minimize erosion from new developments.

Erosion solutions in rural areas often involve education and voluntary stewardship efforts. As another example, the Sonoma County Resource Conservation District developed a Vineyard Management Manual. Completed in June, 1993, the manual provides specifications for treatments and practices aimed at reducing hill slope erosion, controlling sedimentation, and introduces sustainable agriculture concepts that expand grower awareness of watershed sustaining practices. The next phase of implementation includes a demonstration of the practices in the manual to the growers and the public. The Marin Resource Conservation District helps farmers create Ranch Plans, plans which help control runoff and erosion. The Marin Resource Conservation District also produced an erosion control handbook called *Groundwork*.

Erosion and sediment will be discussed in further detail in the polluted runoff background report.

7. Changed Water Patterns (Hydromodification)

a. **Problem.** Many activities can change water patterns. These activities, called hydromodification, include cutting and filling slopes, flood control, water diversion projects, replacing natural drainages with concrete channels, drainage for farmland, depositing dredged material, causing erosion, removing vegetation, and creating hard, impervious surfaces (such as asphalt or concrete). These changes in water patterns can keep riparian corridors from functioning properly. Together these changes can increase the volume and rate of stormwater runoff. Because of the extra runoff, extra pollution can reach the wetlands.

There are many examples of hydromodification in the North Bay. Novato Creek is subject to increased erosion and sedimentation brought on by increased development within the watershed and by flood control activities (City of Novato, 1995). As another example, freshwater diversions and flood control projects may present a problem on the Napa River. The Petaluma River has been subject to extensive modification and dredging activities over many years for navigation, flood control, development, and other reasons.

b. **Solutions.** Solutions include everything from avoiding diversions to creating creek-friendly, nonstructural flood control projects such as recently approved by the Napa County voters for the Napa River. Stream protection ordinances are also widely employed to protect streams from undesirable hydromodification. Many cities and counties have a basic ordinance that restricts changes to a watercourse. For example, Marin County Code, Section 11.08, requires the free and unobstructed flow of creeks in Marin County, and makes it illegal for any person to deposit materials that would interfere with this flow (with limited exceptions). Many North Bay cities and counties also have erosion or grading ordinances. Some cities use their general plans, ordinances, or development standards to cluster buildings and limit the amount of impervious surfaces in new development, thus limiting changes to water patterns.

Although traditional flood control methods often damaged a river, today many flood control agencies work to make sure that their actions are respective of a stream or river's natural hydrodynamics. For example, planners in Petaluma joined forces with the flood control district to create channel design and management guidelines which combine flood control, habitat enhancement, wildlife protection, public access, education and recreation. These guidelines allow a mature riparian canopy to develop, while minimizing the need for long-term channel maintenance. When completed, the demonstration project, along a previously channelized section of Adobe Creek, will include a pedestrian pathway, interpretive signs, and close coordination with local schools. The project also includes a release pool for steelhead trout, with ongoing monitoring by local high school students.

The Marin County Flood Control District employs a creek naturalist to promote riparian protection and to ensure that flood control measures are respective of the natural functions of a stream. The District is currently conducting restoration in Warner Creek in the lower part of the watershed, and is planning a restoration for a portion of Novato Creek.

Other examples of environmental flood control techniques include creating a "meander belt," or a strip of land paralleling the stream to allow the stream to adjust itself to changes in the water flow and thus stream patterns. Another example is designing flood control projects for the appropriate sized-storm. Often, flood control projects are designed to contain a two-year storm (or the size of a storm statistically likely to happen once every other year). However, this storm design often does not consider the effects of upstream development, which can greatly increase the amount of runoff and change the timing of runoff. In these cases the creek enlarges itself, increases its flow, and destabilizes the banks, causing downstream flooding and property damage, among other impacts. Impacts to the wetlands are also possible. Appendix C supplies additional information regarding environmental flood control principles.

Other Riparian Issues

Other riparian issues include permit requirements, riparian restoration, and multi-objective river management.

1. Permit and Buffer Regulations

a. **Problem.** Some farmers have concerns about creek buffers and setback requirements. Many note that the buffers and setbacks are a loss of productive land, land they believe should otherwise be farmed. Farmers want compensation for this loss of production potential (and also for what they perceive to be a decrease in land value). Furthermore, some farmers have claimed that certain setback requirements in the North Bay have not been based on scientific criteria. Some of these farmers would prefer that each stream undergo a scientific study in order to develop equitable and consistent criteria (Judy James, pers. communication).

Finally, the farmers assert that the California Department of Fish and Game (DFG) permit process (modification of stream beds requires a permit from the DFG under the California Fish and Game Code) for streambed alterations can take up to two years, involve considerable expense, and engenders on-going scrutiny by the agency (Judy James, pers. communication). Some farmers view the process as counterproductive, since the difficulty of the process makes it more attractive for the farmers to remove the vegetation illegally without a permit.

Of course, buffers and healthy riparian areas can also help the farmers by protecting valuable farmlands from flooding and erosion, and by maintaining the water quality and the water table (which can help maintain the productivity of adjacent lands). In other parts of the country, farmers have been able to farm the buffers for hay, nuts, fruit, or berries, thus making them economically attractive (USDA Forest Service, 1997). Others using the areas for cattle grazing have actually found that undertaking riparian protection efforts increased, rather than decreased, their net livestock forage (Northwest Resource Information Center, Inc., 1990).[5]

b. **Solutions.** In order to address stream alteration permitting issues, the DFG has undertaken a pilot program in Napa County to streamline the permitting process (specifically, the streambed alteration agreement process, discussed in Chapter 3). Through this process the DFG is working with landowners and the Resource Conservation Districts to develop watershed management plans to protect and enhance certain streams in Napa

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[5] Using strategies such as encouraging more desirable plant species composition, controlling the timing of the grazing, and using separate management strategies for riparian grazing areas.

County. Landowners who are a party to the plan would not need to go through the full streambed alteration agreement process when managing the riparian vegetation along their creeks. Plans for demonstration projects in specific creeks, including Dry Creek and Huichica Creek, are underway.

Possible solutions to make buffers more profitable might include acquisition of riparian easements. Acquisition of riparian corridors or easements along the corridors by public or nonprofit organizations can help protect river habitats. Thus far, acquisition specifically to protect riparian areas has occurred infrequently in the North Bay. Rentals can also be used to protect riparian corridors. For example, the Agricultural Stabilization and Conservation Service (ASCS) sponsors a program called the Conservation Reserve Program (CRP), in which farmers can rent strips of riparian land to the CRP as vegetative filter strips. The U.S. Department of Agriculture sponsors a program called the Wetlands Reserve Program (WRP), which can purchase easements on agricultural lands and provide cost-sharing funds for landowners who wish to restore wetlands.

Additional solutions could include local governments or other organizations, such as non-profit conservancies or the Resource Conservation Districts, working to help reduce the financial impact of riparian setbacks and buffers on farmers. For example, local governments, non-profits and/or Resource Conservation Districts could work to find grants for pilot projects that simultaneously control invasive vegetation and Pierce's disease, while protecting native riparian habitat. This type of study could provide funds to the farmers, thus making buffer zones more profitable. The local governments and/or Resource Conservation Districts could work to find grants for pilot projects that utilize the buffers as native riparian vegetation nurseries. If the market exists, this type of pilot project could provide funding for the farmers to raise an alternative crop: riparian vegetation. Thus, these projects may help make buffer zones more profitable for the farmers.

As another example, these agencies could work to involve and compensate interested farmers for North Bay riparian restoration work. Restoration efforts can require a great deal of farming expertise, as these efforts may require weed control, mowing and mulching, periodic soil removal at the croplands edge, replanting, or herbicide application (USDA Forest Service, 1997). North Bay farmers may be able to provide, and profit from, this kind of expertise. Another example involves flood control. Improved riparian habitat can help control floods downstream. Where appropriate, flood control districts and other benefiting agencies (such as stormwater pollution programs) could consider paying farmers to voluntarily improve riparian habitat on their land.

Still other strategies could involve general plan policies. Marin County's general plan, for example, contains a policy to consider working with the Resource Conservation Districts to establish a fund for farmers who wish to voluntarily fence their cattle away from the stream. Such a program was instituted in Petaluma.

Additionally, interested farmers could be compensated for North Bay riparian management and levee maintenance work on public lands. Some publicly-owned lands in the North Bay, particularly those owned for wildlife protection, are undermaintained, due in part to a lack of operation and maintenance funds. This failure to conduct appropriate maintenance can hurt the neighboring farmlands and the wetlands (for example, if an undermaintained levee fails). Public land managers may lack the farming expertise necessary to maintain their riparian lands. North Bay farmers may be able to provide, and profit from, this kind of expertise.

All of the above ideas would need to be refined and discussed further to see if they are feasible. Still other possible solutions might include more technical assistance. In some cases, increasing riparian habitat can actually improve the profitability of livestock grazing (Northwest Resource Information Center, Inc., 1990). Interested parties should work with their Resource Conservation Districts to determine if their grazing strategy could benefit from riparian habitat protection.

2. **Riparian Restoration.** Most of this chapter focuses on how to protect rivers (and, consequently, wetlands), from threats such as sediment and vegetation removal. However, many communities are working not only to protect the existing functions of the rivers, but also to restore degraded rivers. Many citizen groups, non-profit groups, and public agencies in the North Bay are working to clean up, replant, and stabilize their rivers. Voluntary watershed plans are in place for the Napa River, Huichica Creek, and Sonoma Creek watersheds; all of these plans include restoration. The Marin County Flood Control District, for example, is undertaking restoration of Novato Creek.

Local governments are helping these efforts through their policies. For example, The City of Novato's General Plan requires new developments to restore previously degraded riparian areas as a condition of development approval, where restoration is feasible. A few other general plans in the North Bay contain goals to encourage riparian restoration.

3. **A River With Many Uses (Multi-Objective River Projects).** Riparian habitat protection can become an important part of other stream protection efforts, such as flood control or stormwater pollution prevention. For example, as discussed above, the City of

Petaluma teamed up with the Sonoma County water agency to produce guidelines to protect citizens from floods, while also protecting riparian habitat. In yet another example, the U.S. Army Corps of Engineers teamed up with farmers, environmentalists, and government representatives in the 1980's to create the *Napa Living Rivers Flood Plan*, which relieved flood pressure upstream and created setbacks from the river for the floodplain, rather than channelizing the river through the City of Napa. Urban design became an integral component of the plan, as the project changed downtown Napa's focus once again towards the river. Thus, river protection can go hand in hand with agriculture, urban design, recreation, stormwater management, flood control, and other objectives such as linking wildlife reserves through corridors. Goals for multi-objective projects can include managing stormwater, reducing flood loss, improving water quality, recreation, open space, greenway strips, protecting habitat, wildlife study, aesthetics, increased water supply, and historic/archaeological protection (Tennessee Valley Authority Flood Damage Reduction Program, 1990).

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Rivers and streams usually support plants and animals on their banks and adjacent uplands, called "riparian areas." Riparian areas directly affect the ecological health of the North Bay wetlands, since they deliver nutrients to the downstream wetlands, shade streams to help maintain a proper water temperature for aquatic life, filter out pollutants from entering the watercourse, and hold sediment that would otherwise reach the wetlands. Thus, healthy, functioning rivers and riparian areas are vital to healthy, functioning wetlands.

2. Riparian corridors are important ecosystems that provide many benefits including:

   a) Habitat and food for wildlife. Rivers and streams provide important habitat (food and shelter) for many kinds of aquatic and terrestrial life, including fish, amphibians, insects, migrating and resident birds, and mammals. Furthermore, riparian zones can provide an important connection between habitat types.

   b) Regulation of water temperature. Overhanging trees and streamside vegetation in the riparian areas provide shade, keeping the waters cool as needed for the survival of many aquatic organisms.

   c) Protection of water quality. Riparian vegetation can protect water quality by trapping and filtering out toxins, such as oils, herbicides, pesticides, excess nutrients, and sediments before they reach the stream.

   d) Erosion control. The complex root system of riparian vegetation stabilizes the soil and protects against the cutting action of running water, stabilizing the stream banks and therefore reducing erosion.

   e) Flood control. River and stream floodplains can store floodwaters and riparian vegetation can slow the flow of floodwaters with physical resistance.

   f) Groundwater recharge. Riparian floodplains slow runoff and temporarily store water, allowing additional time for floodwaters to enter the groundwater system.

   g) Recreational and economic benefits. The scenic value of a healthy river or stream system can provide recreational opportunities as well as translate into increased property values.

3. Although no formal inventory exists of North Bay riparian corridors and their conditions, it is safe to say that no pristine waterways exist in the North Bay watershed. All waterways have been impacted in some form by human activities, either directly through modifications of the channel and adjacent land uses, or indirectly by activities upstream that impair water quality and flow. Overall, the streams and rivers in the North Bay share a number of problems, including erosion and sedimentation, flooding, high water temperature, habitat degradation, reduced freshwater flows, and polluted water. Specific threats to riparian systems can be broadly grouped into the following categories:

   a) Removal of riparian vegetation. Riparian vegetation may be removed for many reasons including development, landscaping, crop preparation, or from grazing. Vegetation removal removes important habitat and food sources for wildlife, reduces shade, reduces groundwater recharge, destabilizes streambanks, increases velocity of flood waters, increases sedimentation, and increases the amount of pollutants entering the rivers and streams.

   b) Adjacent activities. Land uses, practices and activities next to a river or stream can degrade riparian habitat. For example, in residential areas, installation of lawns and gardens can displace river vegetation and the application of nutrients and herbicides can lead to pollution of the stream. Inappropriate trails from homes to the creek can trample sensitive vegetation and cause erosion. In commercial or industrial areas, noise and lights can disturb wildlife breeding and foraging. In rural areas, agricultural activities in or nearby a creek, such as grazing or discing, can remove or degrade riparian habitat.

   c) Impacts from upstream and upland development. Because of the connectedness of watershed systems, even uses far away from a stream can harm a riparian corridor. For example, development often replaces soil with hard (or impervious) surfaces such as concrete. Impervious surfaces limit the amount of water that can filter into the soil and recharge groundwater basins, while also increasing runoff which can contribute to flood problems and increase the amount of pollutants reaching streams and wetlands.

   d) Non-native invasive vegetation. Many waterways are plagued by non-native, invasive plant species that can displace native vegetation, may provide only minimal habitat and nutrient benefits to wildlife, and may cause detrimental changes in local hydrology and soil structure.

e) Polluted runoff. When it rains, rainwater can pick up pollutants from many and diverse sources as it runs off city streets, lawns, agricultural area, marinas, and other sites, and bring these pollutants to stormdrains, rivers, wetlands, and the Bay.

f) Erosion and sedimentation. Many activities, such as plowing and discing for agricultural activities, overgrazing, road construction, urbanization, fires, and simple recreational activities such as hiking and cycling, create siltation problems in the streams by disturbing the soil and changing natural runoff patters. Excess sediment causes turbidity problems in waterways, blocking light needed by aquatic plants (and resulting in detrimental impacts throughout the food chain), and can also cover important fish spawning habitat. Excess sediment can also physically smother wetland vegetation, converting the wetland habitat into upland habitat. Furthermore, sediment may carry pollutants thereby decreasing water quality.

g) Changes in water patterns. Activities such as cutting and filling slopes, flood control, water diversion projects, replacement of natural drainages with concrete channels, drainage for farmland, deposition of dredged material, removal of vegetation, and creation of impervious surfaces can alter water patterns (called hydromodification) and keep riparian corridors from functioning properly.

4. Many grassroots, voluntary river protection efforts are underway in the North Bay to combat threats to riparian systems, such as the Napa River Watershed Owner's Manual, the Sonoma Creek watershed planning effort, and the North Bay habitat inventory for Sonoma Creek. Furthermore, many agencies are also undertaking riparian restoration or planning efforts in the North Bay.

5. Local governments may use many tools to protect riparian corridors, such as ordinances, design guidelines and general plan policies. In the North Bay, the most common tools are riparian protection policies in the general plan and streamside buffers and riparian or watercourse-related ordinances.

Policies

1. Riparian areas should be maintained and enhanced wherever possible to preserve the far reaching and varied benefits these important systems provide to the North Bay watershed.

2. Local governments should take steps to minimize threats to riparian corridors, such as preventing the removal of native riparian vegetation, encouraging responsible upstream development, buffering the riparian corridor from adjacent activities, controlling non-

point source pollution and siltation, preventing hydromodification, and encouraging flood control techniques that respect the natural riverine environments. To protect riparian corridors, local governments should adopt creekside protection, enhancement and restoration ordinances. A model of such an ordinance is found in Appendix B of this report.

3. In order to provide a solid foundation for riparian protection, local government policies should include, at a minimum, restrictions for modifying watercourses and removing native vegetation, buffers for riparian areas, mitigation requirements for impacts to riparian habitats, and policies to discourage the planting of invasive vegetation. Local governments should also continue to support riparian protection efforts in the North Bay, such as those of the Resource Conservation Districts, Marin County Stormwater Pollution Prevention Program (MCSTOPP), and grassroots efforts led by farmers, landowners, and non-profit groups.

4. For maximum success potential, creative approaches to riparian protection and restoration should be pursued. For example, local governments together with other organizations (such as non-profits, state and federal governments, Resource Conservation Districts, etc.) could work together to help reduce potential regulatory and financial impacts of riparian protection policies on farmers and land owners. Possible solutions include: local, state, or federal grants for pilot protection or restoration projects; support of permit streamlining for buffer regulations; hiring of farmers for restoration projects and/or riparian buffer maintenance on public lands; compensation for buffer zones from flood control agencies; establishment of a fund for farmers who wish to voluntarily fence their cattle from a stream, or enrollment in current voluntary programs that fund buffers (such as the National Resource Conservation Service's Conservation Reserve Program, which "rents" riparian land from private owners).

5. Local governments should support and encourage riparian inventory efforts, such as those currently being conducted by the Sonoma County and Napa County Resource Conservation Districts. As part of local inventory efforts, local governments should consider identifying sites with the greatest potential for habitat protection and pollutant removal (land trusts could potentially use this information to focus on their voluntary acquisition or protection efforts). Riparian inventory, identification, and restoration should be targeted on a watershed basis when possible to address habitat fragmentation and provide corridors for wildlife by maintaining a continuous stretch of streamside vegetation where possible. Riparian protection on a watershed basis should also include

coordination among the various governments and Resource Conservation Districts to share information, support, and technical assistance.

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APPENDIX A

RIPARIAN BUFFER DESIGN and MANAGEMENT RECOMMENDATIONS

Buffer zones, or bands of vegetated areas adjacent to the water, are a common tool used to protect rivers and streams. This appendix discusses recommendations for the design, implementation and management of riparian buffers. Appendix B then provides two model riparian ordinances applicable at the local government level: one more suitable for cities and urbanizing areas, the other for rural areas.

Multiple-Use Buffers

Riparian buffers can act to stabilize banks, reduce erosion and sedimentation, reduce the volume of runoff, reduce pollutant loads, provide recreation, provide wildlife habitat, and increase property values, among other functions. The appropriate size, design and management of a riparian buffer will depend on the specific site and the desired function of the buffer. For example, a buffer created solely to protect a streambank may be much smaller than a buffer needed to protect wildlife habitat. If the primary purpose of the buffer is to protect water quality, the buffer size may vary according to soil type, slope of the site, depth of the water table, type of vegetation, pollutant concentrations, land use and size of area draining into the buffer, and other factors (Desbonnet et al., 1994).

The goal of the North Bay Wetlands and Agriculture protection plan is to ensure the protection, enhancement and restoration of North Bay wetlands and to protect agriculture, while allowing compatible uses to continue that are consistent with wetlands and agricultural values and functions. The purpose of providing riparian buffers along rivers and streams in the North Bay then, would be to preserve the downstream wetlands and floodplains by: 1) Preventing erosion and sedimentation, 2) reducing the volume of runoff, 3) reducing pollutant loads, and 4) improving habitat for aquatic organisms that may transit between wetlands and streams. However, for a comprehensive approach to resource conservation, these downstream protection goals should not be taken out of context from the additional on-site functions a buffer can provide, such as providing increased flood protection, and providing for wildlife habitat protection and diversity. Therefore, it is most appropriate for this report to make recommendations on size and design for multiple-use buffers, those that will provide a variety of benefits from streambank protection, to pollution flood water reduction, to wildlife habitat.

Although specific size, design and management strategies for an ideal multiple-use buffer will depend upon site specific properties, some general principles are recommended to guide local governments in the North Bay in the implementation of appropriate riparian buffer policies. An "ideal" multiple-use buffer would have several recommended characteristics including:

- A minimum size of 75 feet in width[1] when ever possible
- A relatively flat design with no gullies or channelized areas
- A variety of native plant species suited to the site and the intended purpose
- Utilization of existing riparian areas where possible and otherwise complimentary and/or a reflective of the natural features of the surrounding area
- An implementation mechanism that provides for technical assistance, provides safeguards during the construction process, spells out allowable uses, provides a mechanism for post construction maintenance/repair, and is coupled with an educational program

These recommendations are discussed in detail below.

Buffer Size

The ideal size of a buffer will depend on several factors, including existing riparian functions, values, and sensitivity; buffer characteristics; land use impacts; and the desired function of a buffer. For example, if the purpose of the buffer is to let sediments settle, and the slope on the site is less than 15 percent, the buffer may only need to be 30 feet wide. However, if the purpose is to protect overall water quality, the buffer may need to be 100 feet wide (USDA Forest Service, 1997).

Figure 8 shows examples from the US Forest Service of estimated buffer widths appropriate for providing certain levels of benefits. Table E shows a summary from another source of pollutant removal effectiveness and wildlife habitat value of buffers according to buffer width.

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[1] Unless otherwise stated, buffer widths are measured horizontally from each side of a waterbody. For example, a 50-foot wide stream buffer means 50 feet on both sides of the stream, measured from the top of the stream bank, outwards.

Figure 6
Recommended Buffer Widths for Various Benefits
(Adapted from USDA Forest Service, 1997)

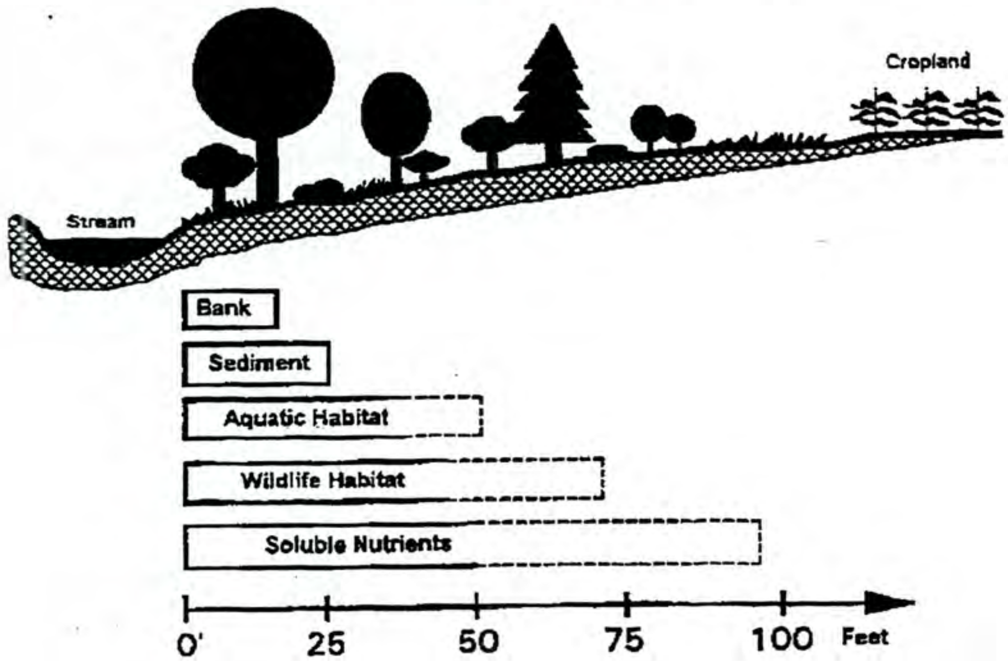

Table E
A Summary of Buffer Benefits According to Width
(Desbonnet et al., 1994)

Buffer Width (ft.)	Pollutant Removal Effectiveness	Wildlife Habitat Value
16	Approximately 50% or greater sediment and pollutant removal	Poor habitat value; useful for temporary activities of wildlife (resting, feeding)
33	Approximately 60% or greater sediment and pollutant removal	Minimally protects stream habitat; poor habitat value; useful for temporary activities of wildlife
50	Greater than 60% sediment and pollutant removal	Minimal general wildlife and avian habitat value
65	Approximately 70% or greater sediment and pollutant removal	Minimal wildlife habitat value; some value as avian habitat
98	Approximately 70% or greater sediment and pollutant removal	May have use as a wildlife travel corridor as well as general avian habitat
164	Approximately 75% or greater sediment and pollutant removal	Minimal general wildlife habitat value
246	Approximately 80% or greater sediment and pollutant removal	Fair-to-good general wildlife and avian habitat value
328	Approximately 80% or greater sediment and pollutant removal	Good general wildlife habitat value; may protect significant wildlife habitat
656	Approximately 90% or greater sediment and pollutant removal	Excellent general wildlife value; likely to support a diverse community
1968	Approximately 99% or greater sediment and pollutant removal	Excellent general wildlife value; supports a diverse community; protection of significant species

There is no consistent standard in place for the appropriate size for a multiple-use buffer as the width will be dependent upon site specifics, available scientific data, and external political, social and economic factors (e.g., how close homes are to a stream in an urban area, the economic value of the land for other uses, etc.). Furthermore, very few studies have determined the overall needs for a multiple-use buffer as it is difficult to determine how buffers of various widths and design will provide the desired benefits. In general, larger buffers will provide a greater diversity of benefits over the long term for wildlife, although even small buffers provide some benefits and are preferred over no buffer at all. To further exemplify the range of buffer sizes in place in various areas, Table F shows some examples from a variety of sources of recommended or required buffer widths.

Table F
Examples of Recommended or Required Buffer Widths

Agency or Organization	Buffer Width	Comments
Natural Resource Conservation Service, Conservation Practice Standard	100 feet or 30 percent of the geomorphic floodplain as minimum, no less than 35 feet (no maximum) for riparian forest buffers.	Minimum widths broken into 2 or 3 specific vegetation zones – minimums are for all zones combined
Conservation Reserve Program (National Resource Conservation Service, USDA)	The lessor of 100 feet or 30 percent of the geomorphic floodplain, no less than 35 feet (150 feet maximum)	Mandatory widths for participation in the Conservation Reserve Program
The Government of Prince Edward Island, Canada	Minimum of 33 feet for all intermittent streams, minimum of 65 feet for all permanently flowing watercourses	Recommended widths, but suggests regulatory change to make them mandatory
University of Kentucky College of Agriculture	55 feet recommended	Includes zones of trees, shrubs and grass
U.S. National Forest Service	Up to 300 for fish-bearing creeks and streams and 150 feet for other creeks and streams	
Texas Best Management Practices for Silviculture, Handbook Texas Forest Service	No less than 50 feet	Also states that to enhance wildlife habitat, the buffer may need to be "significantly wider" than 50 feet
State of Washington, Department of Ecology	100 to 300 feet recommended for wildlife habitat	

In conclusion, there are no consistent rules or recommendations in place for buffer widths. The size of a multiple-use buffer should, at the very least, reflect the minimum width necessary to accommodate the greatest variety of desired functions.

Buffer Design

Beyond size, what would an ideal multiple-use buffer look like? The answer depends again on the site characteristics and the desired functions of the buffer. For example, to create a good water quality buffer in an urban watershed, the buffer designer might first need to look at the site's width, flow velocity, the pollutant load in runoff, the sediment particle size, the slope, and the vegetation, soil composition, depth of water table, presence of organic surface matter, and nearby activities. After considering the site, the buffer would then need to be designed to deposit, recycle, and prevent pollutants and sediments. Just considering the deposit process (which helps settle out the pollutants), the buffer designer may promote runoff in the form of sheet flow, create a slope of 10 percent or less, encourage dense vegetation and plants strong enough to withstand storms, and construct the buffer wide enough to absorb the volume of runoff (Metropolitan Washington Council of Governments, 1995). The other parts of the process (prevention and recycling) require other design considerations. Buffers designed primarily as greenways or wildlife corridors need other design features, such as a zone to protect secondary habitat in case unanticipated events, such as storms or diseases, change the shape or quality of the habitat. A good reference for more information is Jonathan M. Labaraee's *How Greenways Work: A Handbook on Ecology* for more information[2].

Although the design of a buffer will depend then, on the site and desired functions, it is possible to outline some general characteristics that should be included in the design of (or restoration of an existing) ideal multiple-use buffer. The ideal multiple purpose buffer should be relatively flat to promote shallow sheet flow through the buffer, thus maximizing pollutant removal. This increases the time the pollutants have to settle, and reduces the probability of the flow becoming further channelized. The buffer should have no gullies or channelized areas in it. Furthermore, the landscape around the buffer should not promote channelized flow and should reduce sedimentation through plantings or through its very design. In terms of vegetation, the ideal buffer would contain native species that are suited to the site's hydrology and soil chemistry, with well developed root systems to hold soil and prevent erosion. A mix of native plant species of various size, structure, and growth patterns should be encouraged at the site to encourage diversity of wildlife functions and

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[2] This handbook is available from the Conservation Fund, 1800 N. Kent St., Ste 1120, Arlington, VA 22209. Although the document is free, a mailing charge may apply.

resistance to pests, pollutants and natural hazards. Finally an ideal buffer would utilize existing riparian areas where possible and should otherwise reflect and/or compliment the natural features of the area (Desbonnet et al., 1994; Natural Resources Conservation Service, 1997).

Buffer Implementation

An ideal multiple-use buffer must have some sort of implementation mechanism to provide for the design, construction and management of buffers. Communities can implement buffers in a number of ways. For example, in Napa County, many farmers are working with their Resource Conservation District (RCD) to voluntarily create buffers for the rivers, protecting both their farmlands and their environment. Local governments can also require buffers for projects like new subdivisions, using a variety of methods (such as requiring a fixed buffer, a minimum buffer, or tailoring the buffer to each site[3]).

Cities and counties that require buffers generally do so through the land use regulation process, normally through specific stream protection ordinances. Cities and counties and open space districts, such as the Marin County Open Space District and the Sonoma County Open Space and Agricultural District, should integrate riparian and buffer protection into their open space planning and acquisition efforts. Local jurisdictions may also pass buffer ordinances to protect their riparian resources (see Appendix B for two examples of buffer ordinances).

Whatever the specific tool used for providing buffers is, the implementation mechanism should provide for technical assistance, provide safeguards during the construction process, spell out the allowable uses in the buffer zone, provide for post construction maintenance/repair, and be coupled with an education al program.

Technical Assistance. A study by the Metropolitan Washington Council of Governments found that most local governments did not require developers to show buffers on relevant site plans and did not provide adequate technical assistance to help the contractors delineate and design buffers properly (Metropolitan Washington Council of Governments, 1995). Cities and counties wishing to create good buffers should ask developers to delineate buffers on all relevant site plans, and provide solid technical assistance for developers.

Buffer Construction. The Metropolitan Washington Council of Governments study, *Riparian Buffer Strategies for Urban Watershed* (1995) recommends a number of safeguards that should be required during the construction process, including requiring

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[3] For example, in other regions, the buffer varies depending on slope, the size of the floodplain, different classes of water bodies, adjacent uses, and other criteria.

proper buffer delineation and design to receive occupancy permits; fining developers when inadequate sediment control causes alterations in the buffer; making developers responsible for restoring the buffer to its original state or paying for restoration costs; and making developers responsible for revegetating buffer areas accidentally cleared during construction. Research indicates that the design and establishment of the buffer should be closely monitored during construction, and that planners should not assume that developers will know how to interpret design requirements, or will reduce disturbance of the land set aside for the buffer (Metropolitan Washington Council of Governments, 1995).

Allowable Uses. What uses should be allowed in the buffer? In theory, to make the buffer effective, it should be protected from intrusion as much as possible. Studies suggest that hiking and fishing may be allowed in designated areas, although most recreational activities should be discouraged (Metropolitan Washington Council of Governments, 1995). As a general rule, any use that creates impervious surfaces, generates pollution, causes erosion or channelization on a continuous basis after construction, or harms vegetation should not be allowed or encouraged (Metropolitan Washington Council of Governments, 1995; National Resource Conservation Service, 1997). According to the Metropolitan Washington Council of Governments, buffer uses which should not be allowed under any circumstances in urban watersheds include pump houses, septic tanks, water and sewage treatment plants, water-well construction; campgrounds, golf courses, athletic fields, patios and gazebos, and playground equipment; farming and livestock grazing; roads, timber harvesting, strip mining, hydroelectric power generation, and oil and gas wells. Uses that may be acceptable include footpaths and bicycle paths, boathouses and docking facilities, utility lines, stormwater best management practices (BMPs) and maintenance for flood control (Metropolitan Washington Council of Governments, 1995).

Maintenance and Repair. Buffers can fail due to natural changes, such as a heavy storm activity, streambank erosion, upstream development that changes the water flows, etc. Most buffer programs have no mechanism for identifying and coping with these kinds of changes, and no mechanism for helping a property owner repair their buffer. Furthermore, most cities do not inspect their buffers after a large storm.

Buffers can also fail due to a lack of maintenance. In urban watersheds, necessary maintenance can include keeping level areas even and free of debris; removing sediment where it covers the vegetation; grading and reseeding eroded areas of the buffer; preventing dumping of lawn debris, pet waste, and other refuse, etc. (Metropolitan Washington Council of Governments, 1995).

A host of post-construction protections can be suggested including, signing a maintenance agreement with the property owner; periodic buffer inspections; instituting a buffer repair program for public land buffers, or by means of a cost-share program, assisting private property owners in repair of buffers; marking boundaries for public access and discouraging trespass of private property; and protection of buffers against pest infestations (Metropolitan Washington Council of Governments, 1995; National Resource Conservation Service 1997).

Education. Research shows that in many cases, buffers are altered by new homeowners, who may not understand the purpose of the buffer. In one study, new homeowners altered over 95% of the buffers studied. In all of those cases, if the buffer was part of a residential lot, the buffer was eventually replaced by a lawn (Washington State Dept. of Ecology, 1992). Clearly, buffers, particularly in residential areas, need to be coupled with an educational program to help new owners understand the benefits of the buffers and informing all new owners of adjacent property of the benefits and responsibilities of their buffer area, including permitted uses, maintenance needs, appropriate vegetation management, etc. Examples of public awareness measures include signs on the site; pamphlets made available through realtors or the local government; written disclosure required upon sale of property; a mailing to new property owners when they purchase affected land; buffer requirements included in a homeowner's association document; and the buffer being recorded in the deed to or land record of the property.

Costs and Benefits. As discussed in Chapter 2, implementing buffers can be problematic for farmers and developers, because buffers can represent a real or perceived loss of income and increased regulatory problems. Of course, buffers help protect streambanks and farmlands, and can increase the value of real estate. The kinds of costs and benefits of buffers in urban watersheds are shown in Table G. For farmers, buffers can be made more profitable through conservation easements, acquisition, cost-sharing by the flood control districts, harvestable crops, and other tools. For both farmers and developers, strategies which protect the rivers while making the process more flexible could be considered. For example, rather than a fixed buffer width, a developer may wish to reduce riparian buffer widths in less sensitive waters in return for making stream improvements or providing other environmental benefits.

Table G
Comparing Buffer Costs to Benefits
(Adapted from Metropolitan Washington Council of Governments, 1995)

Potential Costs	Potential Benefits
LOCAL GOVERNMENT	
o Staff time (plan review, construction site inspection, post-construction inspection, maintenance)	o Increased property value
o Staff experience and/or training	o Bank stabilization and erosion control
o Technical assistance for developers and contractors	o Low maintenance stormwater management control
o Maintenance equipment	o Reduction in flood damage
o Public education efforts	o Groundwater recharge
	o Preservation of aquatic and wildlife habitat
	o Increased recreational opportunities
DEVELOPERS AND/OR PROPERTY OWNERS	
o Technical surveys and reports	o Increased property value
o Buffer delineation	o Low maintenance stormwater management control
o Landscaping, revegetation	o Reduction in peak runoff volume
o Buffer protection during construction	o Bank stabilization and erosion control
o Loss of land that can no longer be developed	o Increase in diversity of wildlife and plant species
	o Passive recreation area

APPENDIX B

MODEL STREAM AND RIPARIAN ZONE PROTECTION, MAINTENANCE, ENHANCEMENT AND RESTORATION ORDINANCE

Article 1.
Stream and Riparian Zone Protection

Section 1. Purpose. It is the purpose of this Article to provide for the protection, maintenance, enhancement and restoration of streams and riparian zones in a manner compatible with the character of the adjoining property and in a manner which prevents significant adverse environmental impacts to the stream, riparian zone and adjacent property.

Section 2. Applicability. The streams addressed in this article are the following: [name specific streams and/or refer to a specific map that designates the streams and is incorporated into the ordinance].

Section 3. Definitions

1. "Stream bed" means the bottom surface of a stream or watercourse.

2. "Stream bank" means the land at the edge of the stream bed.

3. "Stream environment zone" means a strip of land to be dedicated to the [name city or county] which includes at a minimum the stream bed, stream banks, the riparian zone (see definition below), and any additional land as required in this Article.

4. "Stream restoration plan" means a comprehensive plan for the restoration of the stream environment zone. The plan may require revegetation, removal of exotic, invasive vegetation, flood improvements, stream bank and stream bed stabilization, erosion control, public access, recreation, and aesthetic improvements. A stream enhancement plan (see definition below) may be an element of a stream restoration plan.

5. "Stream enhancement plan" means a plan which increases the value of the stream environment's aesthetic, flood control, biological, erosion control, and/or recreational capacities.

6. "Riparian zone" means the zone where is found the native vegetation which lives along stream banks.

7. "Department" means the California Department of Fish and Game.

8. ["City" or "County"] means the [City or County] of [name specific city or county].

Section 4. Stream and Riparian Zone Regulation.

1. The following provisions shall apply to [the specific named and/or mapped streams in Section 2 above] within the[name city or county].

a. The [name city or county] shall require dedication at the time of a request for any land use, development, subdivision, Planned Unit Development, or building permit approval, of a stream environment zone at least 200 feet wide in its natural or existing state, which shall include the stream bed, the stream banks, and a riparian zone at least 50 feet wide, measured from the top of the channel bank. The exact width will depend on the particular stream environment habitat as determined by an Environmental Impact Report or similar environmental analysis required under the California Environmental Quality Act.

b. The streambed and stream banks shall not be tilled, graded, excavated, or obstructed by any development, construction, or activity associated with such development, nor shall vegetation in the streambed or on the stream banks be cut or removed, except for the following circumstances:

(1) Placement of [name city or county]-approved storm drain and irrigation outflows. Such outflows and the associated drainage facilities shall be designed so as to eliminate or minimize increases in the rate and amount of storm or irrigation water discharge.

(2) Placement of public and non-public utility lines.

(3) Construction of bridges and their connecting roadways.

(4) Restoration, enhancement, or maintenance necessary to prevent flooding, reduce siltation, or otherwise provide for the public health and safety.

(5) Work identified on a stream enhancement or restoration plan approved by the [name city or county] Engineer pursuant to subsection 1. e. Any alteration shall be the minimum amount necessary to achieve the purpose of the project.

All work must be approved by the [name city or county] Engineer. Any alteration shall he the minimum amount necessary to achieve the purpose of the project. Such minor improvements shall follow the standards established in subsection 1. d.

c. The riparian zone determined under subsection 1 (a) shall not be filled, graded, excavated, or obstructed, nor shall vegetation in the riparian zone be cut or removed, except for the following circumstances:

(1) Construction of facilities for low intensity, passive recreation, or conservation uses (e.g., pedestrian and bicycle trails and paths, and foot bridges) approved by the [name city or county] Engineer

(2) Minor restoration and maintenance activity, including removal of debris when necessary to protect the public health and safety, or minor weed abatement activity necessary to protect life or property, or other activities described in subsection 1. b.

Such minor improvements shall follow the standards established in subsection 1. d.

d. All work within stream environment zones shall be kept to the minimum amount necessary to accomplish the goals of this Article. Erosion in excess of natural levels shall be prevented and riparian vegetation shall be protected utilizing the following basic standards:

(1) Removal of riparian vegetation shall be limited to the minimum amount necessary except for exotic, invasive species or other vegetation identified on a stream enhancement or restoration plan approved by the [name city or county] Engineer pursuant to subsection 1. e. If it is determined necessary by the California Department of Fish and Game, any revegetation program carried out as part of such restoration and maintenance shall use indigenous plants approved by the Department.

(2) Development work shall be accomplished between April 15 and October 15. When necessary, extensions of this time period may be granted by the [name city or county] Engineer on a case-by-case basis.

(3) Disturbed areas shall be revegetated by October 15. When necessary, extensions of this deadline may be granted by the [name city or county] Engineer on a case-by-case basis.

(4) Where needed to prevent erosion, exposed soil surfaces shall be hydromulched or stabilized by other erosion control measures prior to October 15. When necessary, extensions of this deadline may be granted by the [name city or county] Engineer on a case-by-case basis.

(5) Special care shall be taken to avoid removal of vegetation immediately adjacent to the stream banks except for exotic, invasive species or other vegetation identified on a stream enhancement or restoration plan approved by the [name city or county] Engineer pursuant to subsection 1. e.

(6) Any revegetation program shall use indigenous plants approved by the Department of Fish and Game.

e. The [name city or county] Engineer may allow alteration of the stream channel and riparian zone as an exception to subsections 1. b., and 1. c. consistent with a riparian enhancement or restoration plan and program approved by the California Department of Fish and Game. Preparation of the plan and program shall conform to the following standards:

(1) The plan shall be prepared by a qualified person(s) experienced in the development and implementation of riparian restoration and enhancement plans.

(2) Prior to plan development, the existing conditions and resources to be preserved and protected shall be documented.

(3) The plan shall clearly identity the goals of the enhancement plan, focusing on vegetation, fishery, wildlife, and channel stability issues. The goals may include flood hazard reduction and public access and passive recreation.

(4) The final plans and specifications shall include vegetation, site preparation, exotic species removal, site grading, erosion control, channel stabilization, preservation methods, fishery enhancement, and revegetation.

(5) The plan shall specify a construction and five-year post-construction maintenance and monitoring program by a qualified restoration team to ensure that the project goals and performance standards are met. The monitoring program shall include provision for remedial action as needed to correct deficiencies. Annual reports and a final report, prepared by the property owner and subject to approval by the [name city or county] Engineer and the Director of the [name city or county

administrative department, e.g., planning, community development, environmental resources], shall document the success of the restoration plan. If the plan is not successful, an additional period of correction and monitoring shall be specified.

(6) The plan shall specify an ongoing management program to ensure the long-term success of the project. The management program shall specify maintenance requirements and the responsibility for implementation and funding.

APPENDIX C

ENVIRONMENTAL FLOOD CONTROL MANAGEMENT PRINCIPLES

Traditional flood control methods, such as channelization and culverting, have harmed, rather than helped, the creeks and rivers. But river protection and flood protection are no longer mutually exclusive. Techniques for achieving environmentally-friendly, multi-objective flood control include encouraging non-structural means of flood control, developing criteria for alternative bank protection other than rip rap, encouraging larger channel sizes to allow the establishment of riparian vegetation, encouraging in-stream debris basins which include capacity for vegetation, encouraging multiple objective two-stage channel designs with low-flow channels, and encouraging levees wide enough to fill multiple needs and use multiple funding sources (e.g., vegetation, roads, and utility rights of way). Flood management projects should include riparian and other natural values in their project cost/benefit analysis. Furthermore, multi-objective project proponents should share the operation and maintenance responsibilities for facilities among the benefited interests (State Water Resources Control Board Nonpoint Source Control Program Technical Advisory Committee, 1994).

A variety of groups, including the Bay Institute of San Francisco, the Pacific Coast Federation of Fishermen's Associations, United Anglers, and the Sierra Club developed a statement of principles of California flood management and floodplain restoration. These principles include the following: (1) restore river systems and functions that improve flood management while also bolstering the effectiveness of existing flood control systems (for example, strengthening existing and properly sited levees at high risk; and restoring the historical capacity of rivers where feasible to better accommodate flood waters); (2) better manage the use of floodplains to minimize taxpayer expense and maximize environmental health; (3) manage the entire watershed to provide the most protection from floods in an environmentally-sensitive way (for example, by discouraging development in wetlands and floodplains, and where possible, replacing non-native hillside annual vegetation with native perennials to reduce hillside erosion); (4) make comprehensive efforts to restore natural floodplain habitat and associated hydrologic functions to levels that take significant pressure off the habitats; and (5) state, local and federal agencies and governments, non-governmental stakeholders, and concerned members of the public should work cooperatively to develop and implement better short-term flood response coordination and funding. A full copy of the statement of principles is available from Jackie McCort or Jenna Olsen at the Sierra Club at (510) 654-7847.

APPENDIX D

Exotic Invasive Plants in California

Plants that are not native to an area[1], also called "exotic" or "alien" species, can potentially cause adverse impacts to an ecosystem. Some exotic plants are particularly invasive and can spread into the surrounding habitats, displacing the native vegetation. An exotic invasive plant species may have more aggressive growth habits than the plants that are native to the area, or an exotic species may be invasive simply because it lacks the competition normally encountered in its native area, does not get eaten by local animals, and/or is immune to diseases that affect the native plant populations. The exotic invasive species may not provide an adequate food source for the local wildlife dependent upon the native vegetation, and the nonnative species may not provide the same ecological services to the ecosystem such as shelter, shading , or soil structure and stability.

The following is a list of invasive wildland pest plants commonly found in riparian areas in California[2].

Scientific Name	Common Name
Arundo donax	Giant reed
Eucalyptus globulus	Tasmanian blue gum
Hedera helix	English ivy
Rubus discolor	Himalayan blackberry
Senecio mikanioides	German ivy
Tamarix chinensis, T. glaaica, T. parviflora, T. ramosissima	Tamarisk, salt cedar
Cardaria drabaB	White-top, hoary cress
Elaeagnus angustifolia	Russian olive
Myoporum laetum	Myoporum
Ailanthus altissima	Tree of heaven
Cirsium arvenseB	Canada thistle
Cirscium vulgare	Bull thistle
Robinia pseudoacacia	Black locust
Schinus terebinthifolius	Brazilian pepper
Vinca major	Periwinkle

[1] There is ongoing debate as to how long a species must reside in an area before being considered native. In California, it is generally agreed that native plant species are those that existed in the state prior to the arrival of Europeans, while those species introduced since that time are considered nonnative.

[2] Adapted from the California Exotic Pest Plant Council, February 1997. More information can be found on the California Native Plant Society Web Site at *http://www.calpoly.edu/~dchippin/exotic.html.*