Information Manual

Riparian Vegetation Management
for Pierce's Disease
in North Coast California Vineyards

Developed By

The Pierce's Disease/Riparian Habitat Workgroup
9/1/2000

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This manual was written and edited by the Pierce's Disease/Riparian Habitat Workgroup, an informal group of growers, resource agencies, researchers, and restoration specialists. If you have questions about this manual, please see Appendix 2 Resources, for more information.

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SECTION I
WHAT'S IN THIS DOCUMENT?

In North Coast California, grape growers produce wine grapes along thousands of miles of stream frontage, where they must accept the dual roles of farmer and riparian habitat steward. Often the natural and agricultural systems co-exist in relative harmony. But in recent years some streamside growers have faced great economic loss from Pierce's disease, a bacterial disease whose vector, the blue-green sharpshooter, lives part of the year in riparian vegetation.

This manual presents methods to manage riparian areas to reduce numbers of blue-green sharpshooters, and thus the threat of Pierce's disease from this vector. This manual also describes ways to manage riparian vegetation while protecting fish and wildlife habitat and satisfying regulatory requirements. One way to reduce numbers of the blue-green sharpshooter is to remove certain riparian plants, replacing them with others. But revegetation for Pierce's disease protection is a complex undertaking that can have consequences well beyond the managed area. Improper removal of blue-green sharpshooter host plants can damage the riparian habitat and violate the regulations of many resource agencies.

Protection of riparian habitat is a very real issue. More than 95% of this habitat has been lost in California, making way for cities, agriculture, mining and other development. The riparian area provides one of the richest habitats for dozens of fish and wildlife species that depend upon it for food and shelter. Many of these species, including salmon, steelhead, and the red-legged frog are threatened or endangered in the North Coast winegrowing region, and many others are rapidly declining. While there are several valid economic reasons for growers to protect riparian habitat—for instance it provides critical stream bank stabilization and creates a buffer from flooding—the need to protect and conserve what little remains of this natural resource is equally important.

Before a landowner may begin a vegetation management project in the riparian area the appropriate agencies must approve the project. The primary agency concerned with riparian vegetation management is the California Department of Fish and Game. It is Fish and Game's policy to work cooperatively with growers to reduce Pierce's disease and improve the riparian habitat.

This manual is a practical handbook for growers. It will also be helpful to regulators interested in learning more about Pierce's disease and the complex issues growers face in managing their land. Resource professionals who prepare revegetation plans can use this document as a reference.

The manual is organized into the following sections:

***Section II*: Pierce's Disease Background** describes the disease and its symptoms, the causal bacterium and the insects that transmit it. Section II also briefly mentions methods, other than vegetation management, to reduce Pierce's disease.

***Section III*: Risk Assessment** provides guidance in determining whether Pierce's disease is a serious risk in a given vineyard, and whether vegetation management is the appropriate response.

***Section IV*: Stream Processes and Riparian Habitat** describes the importance of riparian habitat to fish and wildlife, as well as to property values. It also explains some of the complex processes that occur in streams and floodplains.

***Section V*: Vegetation Management** describes how selective plant removal and revegetation with native plants can reduce Pierce's disease, and preserve or improve the quality of riparian habitats.

***Section VI*: Regulatory Agencies** details the requirements of each agency that may have regulatory authority over a Pierce's disease vegetation management project. It describes how to work cooperatively with agency staff in getting plans approved.

SECTION II
PIERCE'S DISEASE BACKGROUND

Pierce's disease (PD) is a lethal disease of grapevines caused by the bacterium *Xylella fastidiosa*. Diseased vines become non-productive and may die just one or two years after infection. Pierce's disease symptoms first appear in late summer with scorching of leaves and withering of clusters.

Symptoms of Pierce's disease

Vines develop symptoms of PD when the bacteria cause a blockage of the water-conducting system. The first evidence of PD infection usually is a drying or "scorching" of leaves. The leaves become slightly yellowed (chlorotic) along the margins before drying, or the outer edge of a leaf may dry suddenly while still green. Red grape varieties usually have some red discoloration. Typically, the leaf dries progressively over a period of days to weeks, leaving a series of concentric zones of discolored and dead tissue (see A). Often, scorched leaves dry down to the base of the blade and separate, leaving the petiole still attached to the cane (see B).

A) Leaf scalds in concentric rings

B) Bark matures irregularly, petioles remain attached

The woody portions of diseased canes are generally dry, especially on chronically infected vines. The bark on such canes matures irregularly (see B). Mature canes may have tan or brown bark interspersed with islands of green immature bark, and immature green canes may have areas of mature brown bark.

About mid-growing season, when foliar scorching begins, some or all of the fruit clusters may wilt and dry up, or portions of clusters may dry up at any time following fruit set. Red grape varieties may develop color early before wilting and drying.

Usually only one or two canes will show PD symptoms late in the first season of infection. But in young vines, particularly in sensitive varieties such as Chardonnay or Pinot Noir, symptoms may appear over the entire vine in a single year.

Chronically affected vines are slow to begin growth in spring. On canes or arms that had foliar symptoms the preceding fall, new growth will be delayed up to 2 weeks and will be somewhat dwarfed or stunted. Some canes or spurs may fail to bud at all. The basal 2-4 leaves may become chlorotic. Except when severely infected, most vines exhibiting stunted early growth will produce near normal growth from late April or May through late summer, at which time leaf burning reappears.

The vineyard pattern will be concentrated around the source of the blue-green sharpshooter, and will decrease with randomly scattered vines further away from the source. Other diseases and disorders with similar symptoms are: armillaria, phylloxera, nematodes, young vine decline, latent viruses as well as some nutritional and water management issues. "Pierce's Disease on the North Coast" has a good discussion of this subject and is available through your Farm Advisor's office.

** Excerpted with permission from University of California DANR Publication 3343 "Grape Pest Management."*

In northern California, Pierce's disease normally occurs only in localized areas. It is a complex disease and a number of factors are required for it to develop. These include susceptible grapevine plants, *Xylella fastidiosa* bacteria, alternate host plants for the bacteria, xylem-feeding insects to spread bacteria, their host plants, and favorable environmental conditions for the bacteria, host plants and insects.

Fortunately, most vineyards do not have all these elements present and are not at risk from Pierce's disease. Riparian corridors, however, often contain all the factors needed for Pierce's disease to develop. When vineyards are planted adjacent to riparian zones, Pierce's disease can develop to epidemic levels. Understanding the complex nature of Pierce's disease is necessary before an effective riparian management plan can be developed.

Xylella fastidiosa **bacteria**

Xylella fastidiosa is an unusual bacterium because it resides in the water-conducting system (xylem) of plants. In grapevines, it multiplies readily and eventually blocks water movement. When this happens, symptoms of PD appear, the vine quickly declines and will likely die. Many PD symptoms resemble water stress because of the xylem blockage.

Host Plants for *Xylella fastidiosa*

Xylella fastidiosa can reside in many species of plants. In most species, bacteria remain localized in small sections of the plant. In others, however, they multiply and spread systemically throughout the entire plant.

The Pierce's disease strain of *Xylella fastidiosa* also causes diseases in almonds and alfalfa. Another strain causes oleander leaf scorch disease. In most plants, however, the presence of *X. fastidiosa* does not lead to any disease development or recognizable symptoms. These non-symptomatic carriers of bacteria are referred to as symptomless alternate host plants. They include species commonly found in riparian habitats, as well as a wide array of ornamental landscape plants.

Insect Transmission of *Xylella fastidiosa*

Some xylem-feeding insects can acquire *X. fastidiosa* when feeding on infected plants. These insects are referred to as vectors due to their ability to transmit bacteria from one plant to another. Fortunately, most insects do not feed on xylem sap because it is primarily water and is almost devoid of nutrients. Certain types of leafhoppers (sharpshooters) and spittlebugs, however, are xylem feeders and are *X. fastidiosa* vectors.

In the North Coast counties of California, the blue-green sharpshooter is the most important vector of the bacterium (figure 2.1). In southern California the glassy-winged sharpshooter has recently become established as a PD vector, causing severe damage to wine grapes in the Temecula Valley. Not enough is known of the glassy-winged sharpshooter with respect to riparian vegetation to include a discussion of it in this Information Manual. Therefore, the following information will focus on transmission of *X. fastidiosa* bacteria by the blue-green sharpshooter.

When a blue-green sharpshooter feeds on a plant containing *X. fastidiosa*, bacteria are ingested and attach to its mouthparts. When it moves to another plant and resumes feeding, some of these bacteria may be dislodged and injected into the plant. In this manner, bacteria are readily moved from plant to plant.

A blue-green sharpshooter (figure 2.1) is more likely to acquire *X. fastidiosa* from a host plant that is systemically infected with bacteria than one in which the bacteria remain localized. On systemically infected host plants, there is a greater chance that a blue-green sharpshooter will feed upon infected tissue because more of the plant is infected.

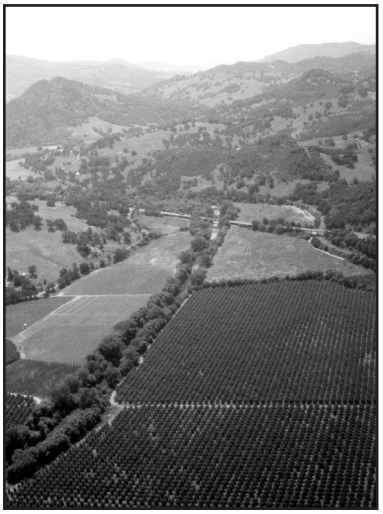
Figure 2.1 Blue-green sharpshooter (dimensions: 1/3")

Once they acquire *X. fastidiosa*, adult blue-green sharpshooters remain infective for life. They are very efficient vectors and can transmit bacteria with initial feeding attempts. Immature blue-green sharpshooter nymphs lose the ability to transmit *X. fastidiosa* when they shed their outer skin (and mouthparts). They can regain it, however, as soon as they feed on infected tissue.

Life Cycle of the Blue-Green Sharpshooter

Blue-green sharpshooter reproduction is usually limited to a single generation per year. The insects overwinter as adults in riparian zones. Specifically where and how blue-green sharpshooters survive the winter months is not well known. They do not seem to venture far from areas where they fed during the fall months. Overwintering adults may carry *X. fastidiosa* bacteria from feeding on infected plants the previous fall.

In early spring, when grapevines begin to grow and air temperatures exceed 60°F, blue-green sharpshooters fly from riparian zones to feed in vineyards. Grapevines are favored plants for blue-green sharpshooter feeding and reproduction due to their rapid springtime growth. Most PD develops from infections that occur during this spring feeding period.



Vineyard and riparian corridor

Adult blue-green sharpshooter females begin to lay eggs in April and continue until they die, usually by late May or June. Newly hatched insects develop through several nymphal stages, but remain on plants where eggs were laid because they cannot fly. Winged adults of this new generation appear from June through August and can survive through the following winter. In late summer and fall, blue-green sharpshooters can be found on a wide range of plants. In some years, additional reproduction may occur in the fall, but usually there is just a single generation of insects per year.

Pierce's Disease Development

Most Pierce's disease results from springtime infections caused by feeding of overwintered adult blue-green sharpshooters. The incidence of PD is greatest in areas adjacent to overwintering habitats for the blue-green sharpshooter and declines with distance. Most PD occurs within 300 feet of the vector source, which matches the springtime distribution pattern of blue-green sharpshooters within vineyards during April and May. This pattern of disease has been stable for over 100

years in some vineyards. Control measures, therefore, are generally aimed at reducing the springtime movement of the blue-green sharpshooter into vineyards.

Blue-green sharpshooters are often widely distributed in vineyards in the late summer and fall, after the new generation of sharpshooter adults develops. Infection of vines can occur at this time, but most of these infections do not result in Pierce's disease. Blue-green sharpshooters generally feed on young tissue. During the summer, this tissue is a long way from the permanent structure of the vine. Most late-season infections are likely eliminated during winter pruning, or the bacteria fail to survive during the cold winter months.

Late-season infections can be serious in young vines, however. Little wood is pruned from young vines so possibly more infections are retained. There may also be physiological reasons why young vines are more susceptible to late-season infections.

Riparian Vegetation Management to Reduce Pierce's Disease

One approach to reducing the severity of Pierce's disease is to alter the assemblage of riparian plants to reduce the number of infective blue-green sharpshooters present in the spring. This can be accomplished by removing specific plants favored by the sharpshooter and replacing them with native, non-host plants.

Plants targeted for replacement are those that the blue-green sharpshooter prefers to reproduce on (reproductive host plants) and those that are systemic hosts of *X. fastidiosa*. By replacing reproductive host plants, fewer blue-green sharpshooters will be present each year. By removing systemic host plants of the bacteria, fewer sharpshooters will become vectors of *X. fastidiosa*.

Other PD Management Options

Riparian vegetation management is just one approach to managing Pierce's disease. Due to the complex nature of PD and the severe impact it can have, several management approaches may be employed at the same time.

Variety and Rootstock

All commercial grape varieties develop Pierce's disease, but some are more susceptible than others. Pinot Noir and Chardonnay are the most susceptible and should not be planted in known PD hotspots. Vines die quickly and the disease develops more extensively in blocks of these varieties. Cabernet Sauvignon, Sauvignon Blanc, Merlot, Syrah and others are less susceptible, but still commonly develop PD. White Riesling, Zinfandel and Chenin Blanc are among the least susceptible. All varieties appear to be highly susceptible as young vines. Choice of rootstock does not affect the susceptibility of the scion variety.

Severe Pruning

Many infections can be eliminated by severe pruning in the fall if Pierce's disease is recognized early enough. In late October or November, prune back symptomatic vines to a few inches above the graft union, then retrain a new shoot the following spring. Such severe pruning should target only those plants that have leaf or fruit symptoms on canes close to (within twenty inches of) the trunk or cordon. Vines with symptoms more than twenty inches from the cordon or trunk can be pruned normally, in most cases eliminating the bacteria. This approach is based on evolving research, and recommendations could change.

Insecticides

Certain insecticides can be used in the vineyard or along the edge of the riparian zone to kill blue-green sharpshooter adults in the spring. Their use is highly regulated and may not be effective in many cases. (See sidebar)

Biological Control of the Blue-Green Sharpshooter

In most cases, the blue-green sharpshooter is already under a high degree of natural control. Compared to most pest insects, blue-green sharpshooters are not abundant insects, even in areas that have major losses to PD. Introducing additional biological control agents would likely have minimal impacts. Unfortunately, blue-green sharpshooters are such efficient vectors that only low numbers are needed to cause damaging levels of PD.

Treatment of Ornamental Landscapes

Riparian zones are not the only source of blue-green sharpshooters that can spread PD. Irrigated landscapes commonly support high populations of sharpshooters and *X. fastidiosa*. Ornamental plantings should be monitored for sharpshooters and treated as needed. Replacement of species found to support reproduction of the blue-green sharpshooter is also an option.

Insecticides for Controlling Blue-Green Sharpshooters

Insecticides may be legally applied to riparian habitats adjacent to vineyards, ornamental landscape plantings, or directly to vineyards to reduce populations of the blue-green sharpshooter. This practice will not eliminate the disease since it does not eradicate the insect.

Currently, there is one material registered for use in the riparian habitat adjacent to vineyards. It is not a selective insecticide, hence many non-target animals, such as insects and birds, are impacted. In particular, birds that use riparian habitat for breeding are very vulnerable if the insecticide is used during the nesting season—from March through June. Because this insecticide has the potential to be extremely disruptive to the riparian ecosystem, many growers choose not to use it. Contact the local UC Cooperative Extension office for information on the most effective and environmentally sensitive treatment strategies.

To apply any insecticide in or adjacent to a vineyard, you must be properly certified by the County Agricultural Commissioner's office.

Several other approaches to managing PD are currently under evaluation. Most cannot be recommended at this time.

- **Trap crops:** growing plants between riparian zones and vineyards to attract blue-green sharpshooters, then treating them with insecticides;
- **Barriers:** planting conifers or using netting to create physical barriers to blue-green sharpshooters' flight from riparian zones into vineyards;
- **Therapeutic treatments:** Various minerals, bactericides and antibiotics are being tested for their ability to cure infected vines. No such products are currently commercially available.

SECTION III
RISK ASSESSMENT

Before initiating a riparian management program to reduce blue-green sharpshooter populations, it is important to assess the risk of Pierce's disease in your vineyard. Riparian management programs require considerable investments of time and money and should only be undertaken when PD is a significant threat to the vineyard. Not all vineyards adjacent to riparian zones will develop Pierce's disease.

Key factors for risk assessment include:

- proximity of the vineyard to the riparian zone
- previous history of Pierce's disease
- presence of blue-green sharpshooters
- presence of host plants targeted for removal
- vineyard age and variety

Proximity of the Vineyard to the Riparian Zone (figure 3.1)

Most Pierce's disease occurs within 300 feet of a source of overwintering blue-green sharpshooter populations (see figure 3.1). If your vineyard is more than 300 feet away from a riparian zone, vegetation management is not an appropriate strategy. If PD is present in such a vineyard, look for other sources of overwintering blue-green sharpshooters, such as ornamental landscapes. If the vineyard is within 300 feet of a riparian zone, consider all of the remaining factors before proceeding with a riparian vegetation management plan.

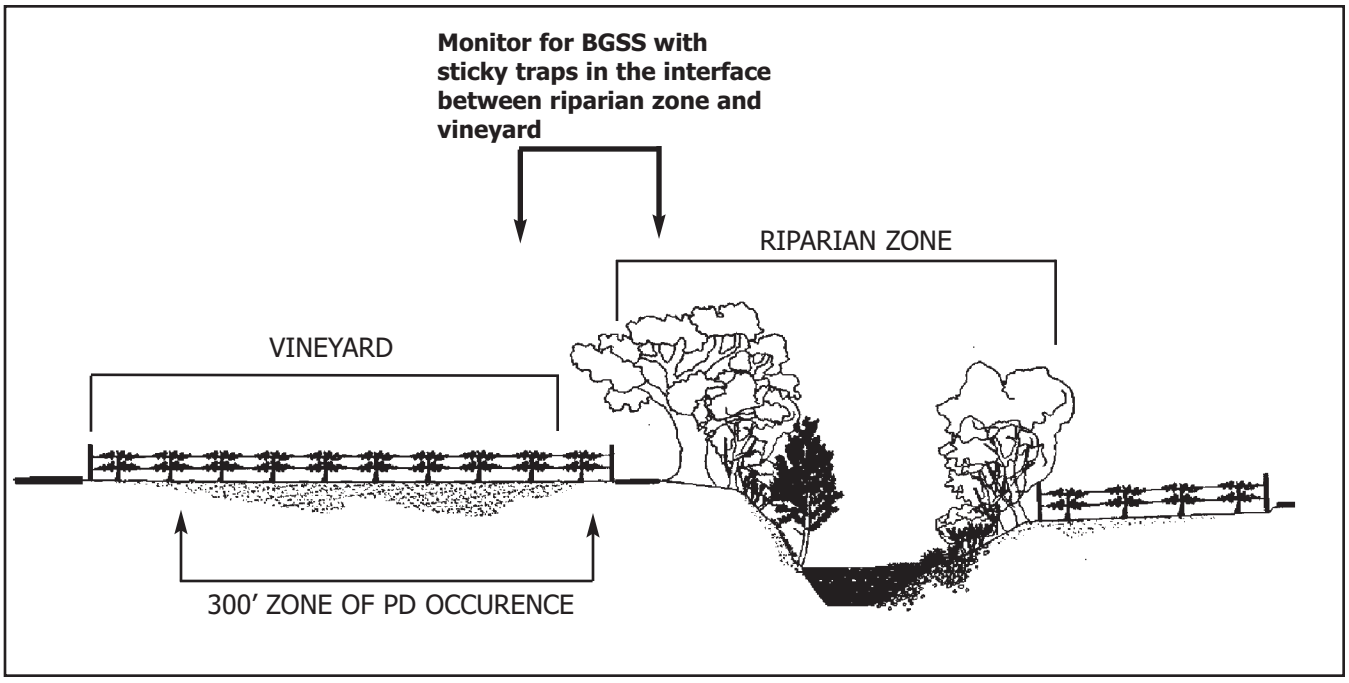


Figure 3.1 Most PD occurs within 300 feet of a source of overwintering blue-green sharpshooter populations

Previous History of Pierce's Disease
Existing vineyards should be surveyed to determine if PD is present and to what extent. Late summer and fall are the best times for this assessment as symptoms are the most obvious. Pierce's disease can be confirmed visually by trained individuals or with laboratory testing (see sidebar). If a site is not yet planted with grapevines, contact neighboring growers, the local UC Cooperative Extension Farm Advisor or the County Agricultural Commissioner to learn if Pierce's disease is known to occur nearby.

Presence of the Blue-green Sharpshooter
For PD to become a problem there must be an insect vector to spread *X. fastidiosa*. Presence of blue-green sharpshooters can be confirmed using commercially available yellow sticky traps. (See sidebar p. 13)

Presence of Host Plants Targeted for Removal
Riparian management programs to reduce blue-green sharpshooter populations target only a few plant species, such as blackberry, wild grape and periwinkle. Section V of this manual discusses all of the targeted plants in detail. Survey your riparian zone to determine which of these plants are present, and to what extent.

Vineyard Age and Varietal
As previously mentioned, all commercial grape varieties develop Pierce's disease, but some are more susceptible than others. Young vines of any variety are at greater risk than older vines.

Not all vineyards adjacent to riparian zones will benefit from riparian management. However, if there is a history of PD in the vineyard, blue-green sharpshooters are present, targeted host plants exist in the riparian zone, and a sensitive variety is planted, then consider developing a riparian management plan. If any of these elements are missing, consider other management strategies first.

Diagnosing Pierce's disease in vineyards

Visual Assessment:
Pierce's disease can be accurately diagnosed by visual inspection alone, but considerable expertise is required. A number of other disorders can present similar symptoms. Late summer and early fall are the best times for visual diagnosis. Individuals with reliable expertise for visual diagnosis might include the local UC Cooperative Extension Farm Advisor, biologists in the Agricultural Commissioner's office, local Pest Control Advisers (PCAs) and growers with a history of PD in their vineyards.

Laboratory Diagnosis:
Diagnostic laboratories can accurately test plant tissue for the presence of *X. fastidiosa*, but the tests are of limited value for confirming PD. Positive test results from symptomatic vines are a good confirmation of Pierce's disease. Negative test results, however, do not mean that Pierce's disease is absent.

In chronically infected vines, bacteria do not move up into the new season's growth until midsummer. Testing of diseased vines before this time will yield false negative results. Even summer and fall sampling can result in false negative results. *X. fastidiosa* bacteria are not uniformly distributed throughout the vine, so a particular sample may simply miss them. In addition, if samples are not handled correctly, the bacteria may die and not respond to the testing procedure. Testing is available at commercial laboratories or through the County Agricultural Commissioner's office. The most common test is a serological assay known as ELISA (Enzyme-Linked ImmunoSorbent Assay). A molecular test that reacts to bacterial DNA is PCR (Polymerase Chain Reaction). It is primarily used at research institutions. Be sure to consult with the laboratory for proper sampling methods and handling instructions.

Confirming and monitoring the blue-green sharpshooter using sticky traps

Blue-green sharpshooter adults are attracted to yellow sticky insect traps. Traps can be used first to confirm the presence of sharpshooters. Once the presence of the blue-green sharpshooter is confirmed, monitoring their activity may be desirable.

Confirm the presence of blue-green sharpshooter

To confirm the presence of the blue-green sharpshooter, place traps at regular intervals in or along the edge of the riparian zone in spring. Number the traps and make note of their location. Inspect traps weekly and replace them when their stickiness is diminished, about every two weeks. Your local Agricultural Commissioner's office, PCA or Farm Advisor can identify suspected insects.

Spring and fall are the best times to determine if the insects are present. Because of their reproductive cycle few adults are present in June and July. During the winter months, adults are inactive.

Monitoring blue-green sharpshooter activity

Monitoring blue-green sharpshooter activity will establish proper application timing if insecticides are used. Timing is crucial if insecticides are to be of any value in reducing Pierce's disease. Spraying insecticides in riparian zones after sharpshooters have migrated into the vineyard will not reduce PD severity. Spraying vineyards when sharpshooters are not present is an unnecessary expense. (see page 10- Insecticides for Controlling Blue-Green Sharpshooters.)

Install sticky traps in February, placing them approximately 100 feet apart along the vineyard edge for vineyard treatments, or in the riparian area itself for riparian area treatments. Do not place traps in the riparian area if you are not planning on using insecticides in the riparian area. Trap catches in the riparian area will always be high relative to traps placed at the vineyard edge. Number the traps and make note of their location. Monitor them at least weekly. During warm periods, daily monitoring may be necessary. Maintain a consistent log of the number of BGSS present in each trap. Change traps when the sticky surface is diminished, about every two weeks. Trapping may be discontinued after July since infections incurred later are generally not persistent. To apply any pesticide in or adjacent to a vineyard, you must be properly certified by the County Agricultural Commissioner's office.

SECTION IV
STREAM PROCESSES AND RIPARIAN HABITAT

Most vineyard owners wish to protect riparian resources while optimizing the value and productivity of their property. These two goals sometimes conflict. For instance, removal of streamside vegetation to control Pierce's disease, without careful revegetation, may seriously harm the riparian system and the fish and wildlife that depend on it. Stewardship of riparian habitat, however, need not always conflict with vineyard productivity. An understanding of stream processes and riparian habitat can help landowners manage their property productively while conserving riparian resources.

Bobcats and other terrestrial vertebrates use riparian areas as hunting grounds and transportation corridors.

Fish and Wildlife Values of Riparian Habitat

Many fish and wildlife species are dependent upon riparian habitat. In part because of the loss of riparian habitat, several of these species are listed as threatened or endangered in the North Coast. Examples include steelhead, Coho and Chinook salmon, red-legged frog, freshwater shrimp and the yellow-billed cuckoo. Many others are in rapid decline.

Fish, especially Coho salmon, Chinook salmon and steelhead trout, rely upon healthy riparian areas in a variety of ways. Riparian trees shade the stream channel, cooling water temperatures and maintaining dissolved oxygen levels. Cool water and high levels of dissolved oxygen are critical to these fish in the summertime. Riparian plants such as willows and cottonwoods drop insects and leaves into the stream, providing food to the aquatic environment. When these trees fall into the stream they provide shelter for various aquatic species.

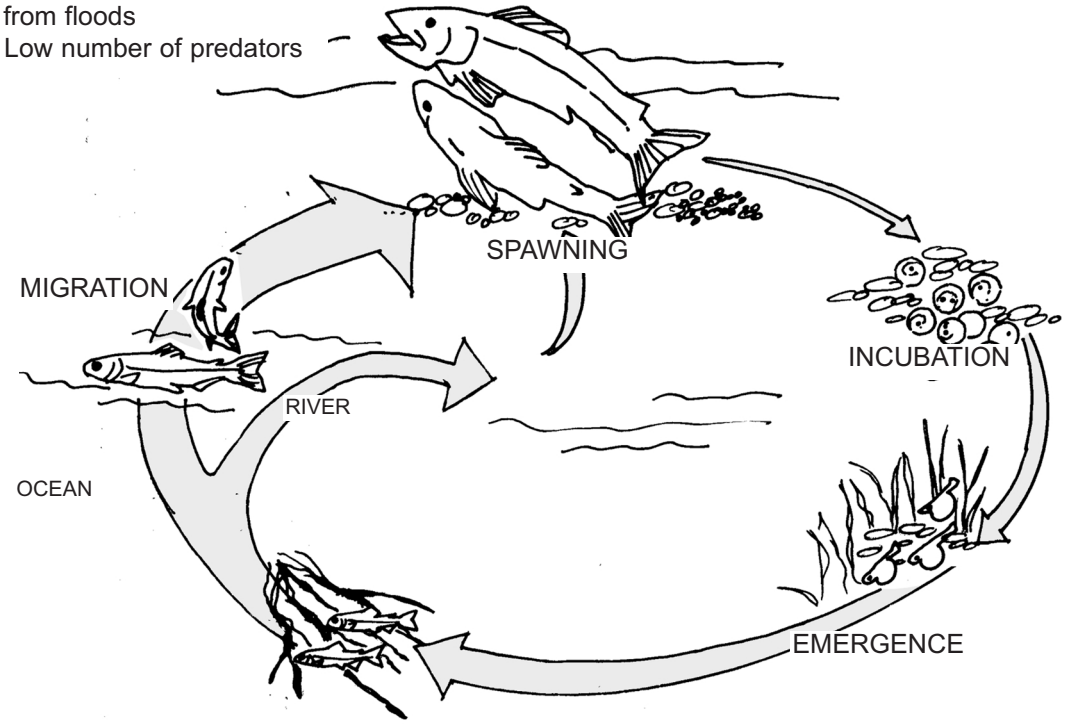
Salmonids, such as Coho salmon and steelhead trout, rely upon healthy riparian corridors.

A stream does not need to run year-round to provide salmonid habitat. Coho salmon and steelhead spawn in the upper reaches of streams and their tributaries while they are flowing in winter. The fry emerge and migrate down to the perennial reaches before the tributaries dry up in summer. These tributaries also serve as important sources of food, spawning gravel, and woody debris that flow to the main stem of a stream during storms. Therefore, alterations to these summer-dry tributaries can have a significant impact on salmonids.

HABITAT REQUIREMENTS FOR COHO SALMON AND STEELHEAD TROUT

ADULT MIGRATION
- Adequate cold water river flows
- Medium flow velocity during migration
- Lack of impassable barriers
- Normal turbidity/high water quality
- Complex habitat with holding areas, shelter from floods
- Low number of predators

SPAWNING
- Clean, medium-sized gravel free of silt
- Adequate streamflow
- Cold water temperatures
- High water quality/low turbidity
- Channel with complex habitat: pools, riffles, riparian trees, large logs
- Lack of siltation
- Gravel bed not subject to excessive scour or siltation



WINTER REARING

SMOLTIFICATION/ OUTMIGRATION
- Low number of predators
- Cold water temperatures
- Cover and complex habitat along river channel
- Lack of barriers in channel
- Adequate flow

SUMMER REARING

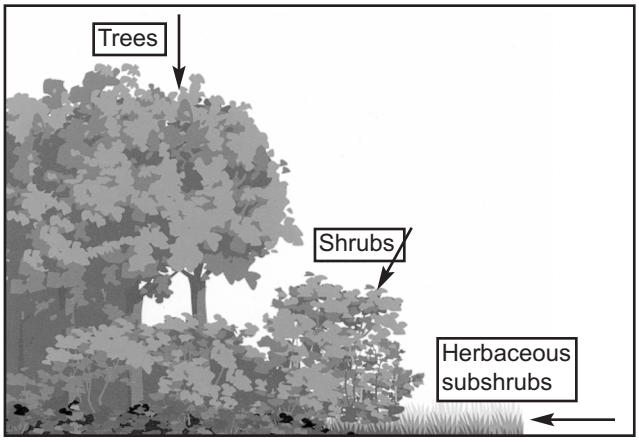
JUVENILE REARING
- Adequate summer cold water flows
- Food production areas
- Channel with complex habitat: pools, riffles, riparian trees, large logs
- Adequate territories for feeding and refuge
- Lack of siltation/high water quality
- Low predator numbers
- Channels without excessive scour or siltation
- Complex habitat for flood refuge areas

INCUBATION/EMERGENCE
- Clean, well-aerated gravel free of silt
- Cold water flows high in dissolved oxygen
- Lack of excessive channel scour and siltation
- Channel with complex habitat: pools, riffles, riparian trees, large logs
- Low predator populations

Graphic Courtesy of:
Laurel Marcus and Associates

Figure 4.2 The kingfisher, *Ceryle alcyon*, is a common streamside bird

In addition to the important role they play in the salmonid life cycle, riparian areas support an abundance of other wildlife species. Over half of the reptiles and three fourths of the amphibians in California, including the western pond turtle, red-legged frog and various tree frogs, live in riparian areas. Large numbers of migratory and resident birds rely on streamside habitat. Over one hundred native species of land mammals are dependent on the riparian zone, including raccoons, ringtails, and river otters. Finally, riparian areas act as wildlife corridors, providing important routes for the yearly migrations of aquatic species (fish, amphibians, insects), land animals (deer, foxes, mountain lions), and birds.



Graphic Courtesy of Stream Corridor Restoration Manual

Figure 4.3 A healthy riparian forest often includes a number of layers of vegetation

In an intact riparian corridor, there is a "layering" effect of plant sizes, shapes and ages that promotes wildlife diversity. A mature riparian forest has a low layer of groundcover, an intermediate layer of shrubs and small trees, and a high canopy of trees and vines. These different layers provide many sites for shelter and food for birds, insects and mammals. In addition, large trees will mature and die, leaving standing snags that provide habitat for cavity nesting birds and other terrestrial wildlife. (see figure 4.3)

Structure and Composition of Riparian Plant Communities

The plant species in riparian communities differ widely depending upon the character of the watershed and the stream's location within the watershed. The composition of a riparian community is determined by many things, including the stream slope (gradient), light availability, water availability, flooding and soil conditions.

At the headwaters of a stream, the gradient is often steep and the riparian vegetation may not vary from the surrounding plant community. Headwater areas in Napa and Sonoma counties may be inhabited by riparian species such as coast live oak, big leaf maple and California bay laurel.

Further downstream, as the gradient decreases, the riparian corridor begins to differ from the surrounding plant community. The canopy is often dominated by trees such as white alder, Oregon ash, Garry oak, big leaf maple, box elder, valley oak and willow. Sunny openings often provide habitat for species such as mulefat. Other species frequently associated with this community are coast live oak, buckeye and California grape.

The alluvial areas of rivers and streams, flowing through broad, flat, valleys may provide year-round surface water. Because the channel is wider, the tree canopy often does not overlap across the stream. Sunlight can penetrate and allow for development of dense stands of active channel species such as willows, cottonwoods and mulefat, with alder often dominating the water's edge. Blackberry, California rose, snowberry and Santa Barbara sedge may be prevalent on the floodplain and stream-banks. Streams in these alluvial areas tend to meander and historically included a broad floodplain gallery forest with backwater sloughs, oxbow lakes and floodplain wetlands.

Riparian Habitat Development

Natural physical disturbance, such as flooding, is a requirement of a healthy riparian system. An understanding of the disturbance patterns in riparian plant communities is critical to creating sustainable habitat management and restoration plans. It helps guide the selection of appropriate plant species based on their location in the riparian zone, and the frequency of disturbance.

Flooding

The most severe flood disturbance occurs in the active channel, which frequently receives high energy flows in winter. The plants in the active channel tend to be adapted to great hydraulic force, and are often capable of re-sprouting after being torn up and re-deposited downstream. Active channel plants also tend to require large amounts of water, and must tap into the groundwater to survive. Examples of these active channel species include willows, cottonwoods and alders.

Plants found on the floodplain, above the active channel, are less tolerant of flood disturbance and require less water than active channel plants. Examples of these floodplain species include valley oak, big leaf maple, buckeye and California bay laurel. Floodplain areas tend to have many more species than active channel areas, with several types of vegetation, including large canopy trees, shrubs, vines and herbaceous groundcovers. Mature floodplain riparian plant communities, with their multi-layered habitat, may require one hundred years or more to develop, while the active channel habitat in the scour zone is often only a few years old.

Invasive Plants

Invasive plants pose an increasing threat to native riparian habitats. These plants - often from Asia or Europe - are capable of rapidly taking over native riparian areas. In general, native wildlife species are not adapted to use these exotic species for food or shelter. Because of this, the invasion by exotic species can severely degrade the value of riparian areas for fish and wildlife. Several invasive plants, such as periwinkle and Himalayan blackberry, are known hosts of *Xylella fastidiosa*. Others, such as tree-of-heaven and giant reed, are considered such a threat to riparian habitat that regulatory agencies encourage their removal and replanting with appropriate native species. Removal of these invasive plants as part of a vegetation management project is recommended to improve the long-term success of the project.

Invasive Plant List

Common Name	**Latin Name**
tree-of-heaven	*Ailanthus altissima*
English ivy	*Hedera helix*
large periwinkle	*Vinca major*
Himalayan blackberry	*Rubus discolor*
giant reed	*Arundo donax* (figure 4.4)
tamarisk	*Tamarix sp.*
Scotch broom	*Cytisus scoparius*
Cape ivy	*Delairea odorata*

Figure 4.4 *Arundo donax*, giant reed, is a highly invasive plant species in California river systems.

Economic Values of Riparian Habitat

Riparian habitat provides many benefits to streamside landowners. For example, a wide strip of riparian vegetation can offset flood damage to vineyards by acting as a "sieve" for trees and other debris that may wash in during large floods. Riparian vegetation also traps fine sediments and other pollutants, thereby preserving water quality. Because of their deep roots and dense growth habit, riparian trees, shrubs, and grasses provide excellent protection against bank erosion, helping to stabilize streambanks.

In addition to assisting with flood protection and erosion control, riparian vegetation may play a role in integrated pest management. Cavity nesting riparian bird species such as kestrels and owls prey on rodents in vineyards. Other cavity nesting birds such as wrens, tree swallows, oak titmice and bluebirds may help reduce populations of pest insects. Bobcats, coyotes and foxes also use riparian areas to prey on rodents.

Figure 4.6 American Kestrel, *Falco sparverius,* is one of 20 species of cavity nesting birds in Sonoma County. These birds may help reduce populations of pest insects and rodents.

SECTION V
VEGETATION MANAGEMENT

This section provides information to guide landowners as they begin a vegetation management plan. Creating and implementing such a plan can be a complex process, taking six months to one year for design and approval, and several additional months for implementation. Please see page 32 for an Example Project Outline.

The landowner (or consultant) should become acquainted with the stream processes and natural habitat of the site to create a plan that works within the local riparian ecosystem (see Section IV). Permits must then be obtained from the Department of Fish and Game, and possibly other agencies, before work can begin (see Section VI).

Goals of Vegetation Management for Pierce's Disease

Vegetation management should foster a diverse, functioning natural plant community, while creating unfavorable conditions for the blue-green sharpshooter, thereby reducing the incidence of Pierce's disease in nearby vineyards. While certain native and non-native plants may need to be removed, they should be replaced with other native species that will fill the ecological role of the removed plants.

A successful Pierce's disease revegetation project will:

- establish a diversity of native plant types (such as trees, shrubs and vines) and plant species in the riparian area
- provide wildlife habitat
- minimize erosion
- resist re-invasion by weeds and blue-green sharpshooter host plants
- require minimal annual management

Planning and Permits

The California Department of Fish and Game is the lead agency for riparian vegetation management projects. Such projects come under Fish and Game Code 1603, and may require a Streambed Alteration Permit. Small amounts of vegetation removal and replanting may not require a Streambed Alteration Permit, but it is still necessary to notify the Department of Fish and Game to determine if a Permit is necessary. Other agencies also have jurisdiction over the riparian area. Please see Section VI for more information on regulatory agencies and their requirements.

Major Host Plants for Pierce's Disease Management

The perennial plants on the following pages are the major breeding hosts for the blue-green sharpshooter in Napa, Sonoma, and Mendocino counties. Most are also systemic hosts of *Xyella fastidiosa*. Vegetation management to reduce Pierce's disease involves replacement of these species with native plants that do not host the blue-green sharpshooter.

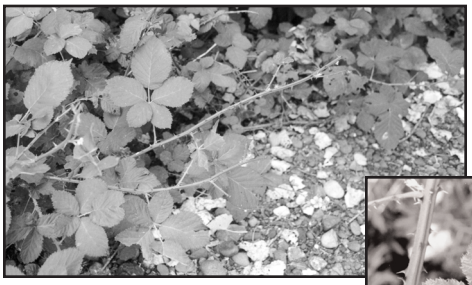
Non-native host plants

Common name	Latin name
Himalayan blackberry	*Rubus discolor*
periwinkle	*Vinca major*
wild grape (escaped cultivar or *Vitis californica* hydrid)	*Vitis sp.*

Native host plants

Common name	Latin name
California blackberry	*Rubus ursinus*
California grape	*Vitis californica*
mugwort	*Artemisia douglasiana*
stinging nettle	*Urtica dioica*
mulefat	*Baccharis salicifolia*
blue elderberry	*Sambucus mexicana*

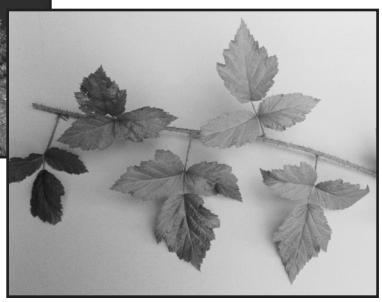
Non-native Host Plants



Himalayan blackberry (*Rubus discolor*) is a common non-native, invasive plant found throughout California and the Pacific Northwest. Although it grows most vigorously along creeks in the full sun, it may be found in partial shade. Blackberry provides erosion control along some stream banks. Any Pierce's disease management site should be evaluated for erosion potential before blackberry is removed. If it is determined that the stream bank will be exposed to erosion when blackberry is removed, the landowner must provide erosion protection. (See Stream Bank Stabilization, p. 31)

Periwinkle (*Vinca major*) is a common non-native invasive plant found along creeks in northern California. It is a low-growing groundcover. It is very tolerant of shade, and can be found as an extensive understory in riparian forests.

Native Host Plants



California blackberry *(Rubus ursinus)* is a common native riparian plant throughout California and the Pacific Northwest. Although it grows most vigorously along creeks in the full sun, it also grows in partial shade. It is often found growing with Himalayan blackberry.

Wild grape *(Vitis sp.)* is found on the edges and in the overstory of the riparian forest, twining up trees. It is most vigorous (and most attractive to the sharpshooter) in full sun. The native wild grape (*Vitis californica*), as well as many escaped cultivars and hybrids (*Vitis sp.*) grow in riparian areas.

Mugwort *(Artemisia douglasiana)* is a perennial native plant with many stems arising from a system of rhizomes. Shoots die back in late summer and re-grow from roots in winter. Mugwort is found in full sun and partial shade. It grows vigorously in the late winter through the middle of spring.

Stinging nettle *(Urtica dioica)* is a perennial native plant with many stems arising from a system of rhizomes. Shoots die back in fall and re-grow from roots every spring.

Mulefat *(Baccharis salicifolia)* is a perennial native shrub found on streambeds and banks. It grows vigorously from the late winter through spring, remains green through the summer, but partially dies back in fall.

Blue elderberry *(Sambucus mexicana)* is a common native shrub or small multi-trunked tree found in riparian areas throughout California. It thrives in sunny areas. Elderberries growing in shade are not as vigorous, and will not be as attractive as hosts to the blue-green sharpshooter.

The following annual plants can also support breeding of the blue-green sharpshooter in riparian habitats. These summer annual host plants will serve as major breeding hosts only if they reach sufficient size in spring or if significant numbers of overwintering (egg-laying) adults survive later than normal in spring.

Common name	**Latin name**	**Plant type**
Lamb's quarters	*Chenopodium album*	winter annual
Mexican tea	*Chenopodium ambrosioides*	summer annual
Cocklebur	*Xanthium strumarium*	summer annual

There may be other plant species that have not yet been identified as important breeding hosts of the blue-green sharpshooter. The above list is the most current as of September 2000.

Selective Host Plant Removal

Once approval has been obtained from the Department of Fish and Game, selective plant removal may begin. Selective removal is the removal of targeted host plants, leaving all others undisturbed.

Work crews must be trained in the identification of the blue-green sharpshooter host plants to be removed, as well as the non-host plants to remain. It is very easy to overlook and mistakenly remove young trees and shrubs that should be left undamaged. A supervisor knowledgeable in the identification of native plants and blue-green sharpshooter host plants should instruct the crew during a training period, and oversee them during removal. It is often useful to flag examples of non-host species with one color, and host species with another.

Blue-green sharpshooter host plants can be selectively removed using mechanical methods, herbicides, or a combination of both.

Mechanical Methods

Mechanical removal of host plants can be done with a variety of hand tools, including machetes, chain saws, weed trimmers, bow saws, pruners, etc. The type and size of the plant to be removed will determine the best tool to use. Use of heavy equipment for the removal of host plants is normally not an option because it results in extensive damage to plants and soil in the riparian area.

Cut off woody plants as close to the ground as possible. Plants with extensive roots and rhizomes are difficult to kill by cutting alone, and may require herbicide application (see below).

Plant debris can be removed from the riparian area or can be left in place for wildlife habitat, depending on the location and amount of debris. Leaving the debris behind, in some cases, may interfere with easy access for replanting and maintenance. If left in the floodplain, the debris could wash downstream during floods, causing possible debris jams and flood hazards.

July through October is the best time to physically remove host plants. Vegetation removal during this time minimizes disturbance of birds and other wildlife, which breed and rear young earlier in the spring and summer. Also, the ground is firm and dry, and rainfall that may interrupt work is less likely to occur.

Herbicide Control

Herbicides can be used to kill host plants. The specific herbicides to be used will depend upon current regulations of herbicide use in riparian zones. Many herbicides are restricted from use in riparian areas because of their potential danger to fish and amphibians. Consult your County Agricultural Commissioner or local Pest Control Adviser for more information.

The following methods assume use of a non-selective, systemic herbicide. A variety of application methods can be used:

- apply herbicide directly to the whole plant;
- cut the plants down and ***immediately*** apply an herbicide to the cut stumps;
- cut the plants down and apply an herbicide on resprouts if they develop.

In many circumstances the second two options—cutting the plants down first and then applying herbicide—will be preferable. Herbicide treatment of stumps and sprouts requires less chemical than on whole plants, and potential of herbicide drift is less. In some cases, however, such as the removal of periwinkle, it may be more practical to apply herbicide without cutting. Also, when blackberry is protecting eroding stream banks, it may be desirable to apply herbicide without cutting, in order to leave the dead plant mass on the banks for erosion control the first year.

Timing herbicide applications is very important. For example, periwinkle responds best to herbicide applications in summer (June, July), while blackberry responds best in fall just prior to dormancy.

When applying herbicide to resprouts, the sprouts should be no more than one foot tall, and the new leaves should be fully expanded. For more information, consult your local Agricultural Commissioner

or Pest Control Adviser, or refer to the UC Davis Pest Management Guidelines: www.ipm.ucdavis.edu/PMG/selectnewpest.home.html.

Plant Name		Removal Method				
		Mechanical Method	Systemic Herbicide[1] (apply to:)			Notes
Common Name	Latin Name	Cut Plant at ground	Whole Plant	Cut Stump	Re-sprout	
Himalayan blackberry[2]	*Rubus discolor*	✓	✓		✓	Cut plant and apply herbicide to regrowth or apply herbicide to whole plant in Sept.
California blackberry	*Rubus ursinus*	✓	✓		✓	Cut plant and apply herbicide to regrowth or apply herbicide to whole plant in Sept.
periwinkle[2] (large)	*Vinca major*	✓	✓		✓	"Weed wack" plant in summer and apply herbicide to regrowth or apply herbicide in June or July. Reapply as needed.
California grape	*Vitis californica*	✓		✓	✓	Cut in late summer or fall. Apply herbicide to stump and regrowth.
Mugwort[2]	*Artemisia douglasiana*		✓		✓	Apply herbicide in summer. Reapply as needed in spring.
stinging nettle	*Urtica dioica*		✓			Apply herbicide in spring.
mule fat	*Baccharis salicifolia*	✓			✓	Cut in late summer or fall. Apply herbicide to regrowth.
blue elderberry	*Sambucus mexicana*	✓			✓	Cut in late summer or fall. Apply herbicide to regrowth.

[1] Always consult a Pest Control Adviser before using any herbicide for proper selection of herbicide and application rates, and follow label instructions.

[2] The most difficult plants to remove will be blackberry, periwinkle, and mugwort. All will resprout vigorously for several years from underground stems. For blackberry, application of herbicide is most effective in late summer, just before the plant goes dormant. At this time the plant is drawing sugars to the roots, and will carry the herbicide there too. With all three plants, persistent follow-up over the years is required.

Native Plants for Revegetation

To complete a riparian vegetation management project, the site must be revegetated with appropriate native species. The appropriate species are those native plants that evolved in the riparian zones of local streams. Most plants support *Xylella* bacteria to some extent, so it is not possible to create a *Xylella*-free riparian zone. But it is quite possible and effective to select plants that are not breeding hosts for the blue-green sharpshooter vector.

The following plants are recommended for use in riparian vegetation management projects where appropriate. They have been extensively sampled and found not to support breeding populations of the blue-green sharpshooter. Before choosing plants for a revegetation project, survey your area to determine the appropriate species (see Typical Riparian Transect, p. 27) or consult with a native plant specialist.

Trees

Common name	**Latin name**
coast live oak	*Quercus agrifolia*
California bay	*Umbellularia californica*
California buckeye	*Aesculus californica*
valley oak	*Quercus lobata*
bigleaf maple	*Acer macrophyllum*
black walnut	*Juglans hindsii*
Oregon ash	*Fraxinus latifolia*
box elder	*Acer negundo*
white alder	*Alnus rhombifolia*
Fremont cottonwood	*Populus fremontii*

Willows

Common name	**Latin name**
arroyo willow	*Salix lasiolepis*
red willow	*Salix laevigata*
sandbar willow	*Salix exigua*
yellow willow	*Salix lutea*

Shrubs

Common name	**Latin name**
coyote brush	*Baccharis pilularis*
snowberry	*Symphoricarpos albus*
spice bush	*Calycanthus occidentalis*
wild rose	*Rosa californica*

Pictured above: snowberry is a beautiful native shrub

Grasses and Sedges: Riparian grasses and sedges do not support breeding populations of blue-green sharpshooters. These plants play an important role in the ecology of the riparian zone, and should be included in revegetation projects where appropriate.

Revegetation Design

General Design Strategy

It is important to preserve and enhance existing tree cover in the riparian zone to provide dense shade. Blue-green sharpshooters are not found in large numbers in deep shade, because host plants (with the exception of periwinkle) will not usually grow with the vigor that the insect prefers. A dense canopy of trees with an understory of non-host perennial shrubs will also minimize maintenance costs. It is important to plant a variety of trees and shrubs rather than just one or two types, to provide diverse shelter and feeding sites for wildlife.

In general, restoration is easier and more successful when the design is in concert with local environmental conditions. The more the restoration follows the native vegetation patterns, the lower the restoration and maintenance cost, and the greater the success rate. If your site has a significant remnant native plant population, the restoration should enhance what is already there.

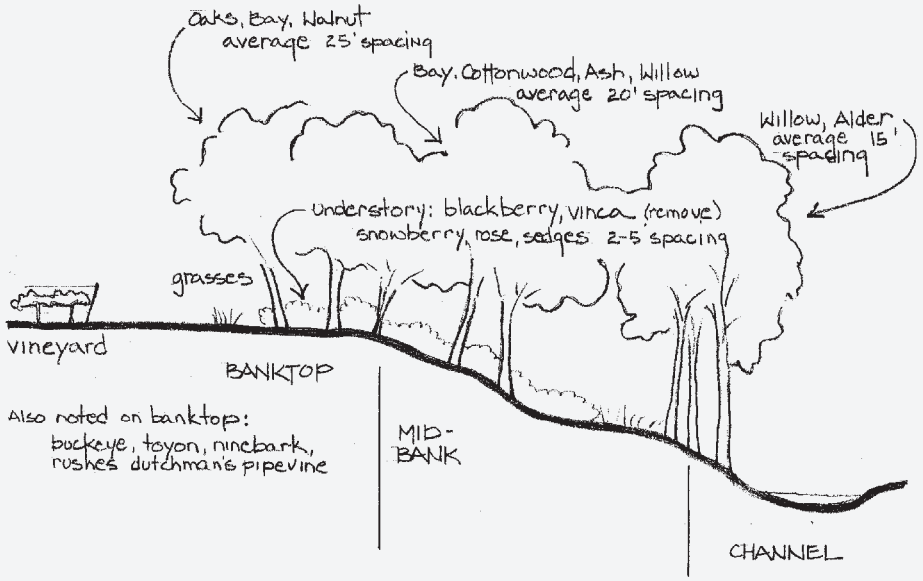
Plant Choices for Various Site Conditions

There is no single combination of plants that can be prescribed for all riparian sites. The preferred plant composition and structure of a given riparian zone will vary from place to place. While some locations are suitable for a riparian gallery forest with its mosaic of understory plants, other locations will support only willows and shrubs.

As discussed in Section IV, different plants grow in different positions along the stream, according to their tolerance of flooding and drought. If your site has a healthy and diverse native plant community, identify the existing native plants and their locations. Use the same plants and patterns to replace host plants that were removed and to fill in any gaps at your site. If your site has few native plants, it is worthwhile to evaluate the most intact neighboring riparian areas and use them as examples for your revegetation. (see Typical Riparian Transect)

Typical Riparian Transect

To identify the natural composition and structure of your riparian plant community, create a transect at one location on your site (or several locations if your site is large and varied). Establish a line from the edge of the riparian vegetation to the water; the line should be perpendicular to the creek. Along this transect line, record the names of the plants you find. Also record the spacing between plants and their elevation above the stream-bed. Sketch the approximate shape of the cross-section and plant locations. This exercise will clarify the type, location and spacing of the plants you will use.



Transition Zone

There will be a transition zone at the edge of the riparian overstory, near the vineyard. This is an area where there is abundant sunlight, creating a potentially high-risk area for blue green sharpshooter host plants. Vigorous control of host plants is most important in this zone. This area should be planted with shrubs and grasses that will not host the blue-green sharpshooter. The newly installed plants will compete with sharpshooter host plants, slowing their return to the site.

Revegetation Methods

Groundcover establishment

Planting a native grass or sedge groundcover may be valuable at your site, depending on the local conditions. In heavily wooded areas, it is unlikely a groundcover will be required. However, in sunny areas, such as the transition zone, a grass or sedge groundcover may be important.

Installing a successful native grass stand is similar to standard erosion control grass installation, but important details differ. For instance, a weed-free straw (such as wheat straw, or native grass straw) must be used to mulch the newly seeded area. In addition, care must be taken to suppress competing annual grasses, usually by timed mowing for the first few years. Consult with your local Resource Conservation District, or UC Cooperative Extension for additional information or a list of referrals for native grass and sedge establishment.

Tree, shrub, and perennial establishment

Trees, shrubs, and perennials are usually introduced as container plants. Two exceptions are willows, which are often planted as cuttings, and oaks, which are often planted as acorns. Bare-root stock can also be used instead of container stock. However, bare-root stock is often difficult to locate because few nurseries produce it. For genetic continuity and to achieve the best survival rates, these plants should be propagated from nearby seed or cutting sources.

Spacing of plants depends on the species, the goals of the project, desired densities, and many other factors.

Common Containers	**Size**	**Uses**
5 1/2" leach tubes	1 1/2" X 5"	Best for plants with fibrous root systems
8" leach tubes	1 1/2" X 8"	Best for plants with fibrous root systems
tree bands	2 1/2" X 5"	Good for trees and shrubs
dee pots	2 1/2" X 10"	Good for trees and shrubs
1 gallon tree pot	4" X 14"	Generally used for trees
1 gallon standard	6 1/8" X 8"	Commonly available in landscape nurseries

Plants should be installed during the winter, after rains have thoroughly saturated the ground. Because of the dangers of planting on the stream bank during high-flow periods when the ground is slippery and the current swift, it is best to delay projects until flows recede between winter storms.

When installing plants, dig holes slightly larger than the width and depth of the root ball, crumbling any large soil clumps. Partially refill the hole, firmly tamping the soil to create a firm base for the new plant. Place the plant with the top of the root ball slightly above finish grade, to allow for future

settling. Fill the hole and tamp firmly to remove any air pockets. Irrigate immediately, ensuring that the water soaks deeply, unless the ground is already saturated.

Where damage from domestic animals and wildlife is a concern, consider protecting plants with shelters (except those that will be in flood-scoured areas). Shelters should be firmly staked and tied so that they will remain upright (see Figure 5.2). There are a variety of shelters available, ranging from chicken wire enclosures to plastic tubes. All of these methods have proven successful if they are maintained and weeds are controlled. Shelters should be removed as soon as the plants begin to outgrow them (two to three years).

Weeds should be carefully controlled in revegetation areas before and after installation. Plants can become lost in the weeds, increasing maintenance costs and reducing project success. Mow tall weeds before installation, and consider using weed mats (three foot diameter sheets of specially designed woven or perforated plastic) around each new plant.

Drip irrigation is recommended in the first year or two especially if the plants are installed during the dry season or during a drought. Irrigation is particularly helpful for plants in sunny areas at the top of bank. Irrigation incurs some extra expense during installation, but pays for itself in increased plant survival.

Deep, infrequent watering stimulates the plants to develop the extensive root systems that will help them survive the dry summer months. If plants are over-watered, or receive frequent shallow irrigation, they may develop surface roots. Each plant should receive approximately 2 gallons of water every two to three weeks during the first summer. The watering frequency can be reduced to once monthly during the second summer.

Long-Term Management

The installation should be maintained and monitored for a minimum of 3 years from the time of final planting. During that time, weeds should be controlled around new plants, dead or failing plants should be replaced, and drip irrigation should be maintained. Every fall check for plant mortality and replace plants that have died or are in severe decline. Each spring, and regularly in summer, check all drip irrigation lines and emitters to ensure that they are clear and functioning properly.

Keep weeds clear within a one- to two-foot radius of each plant during the maintenance period, while protecting regenerating native plants. This will require that maintenance workers recognize the appearance of all seedlings and young shoots of native plants that grow in the area. After the first year, wild rose, dogwood, sedge and snowberry should begin reproducing by runners – new plants will appear around the base of the "parent" plant. Carefully remove weeds in these plantings, while allowing the runners to grow.

Hand-removal of unwanted plants is recommended. If herbicides are used, ensure that there is no drift to desirable plants and seedlings. Also, check for and remove weeds from inside of all plant shelters each year.

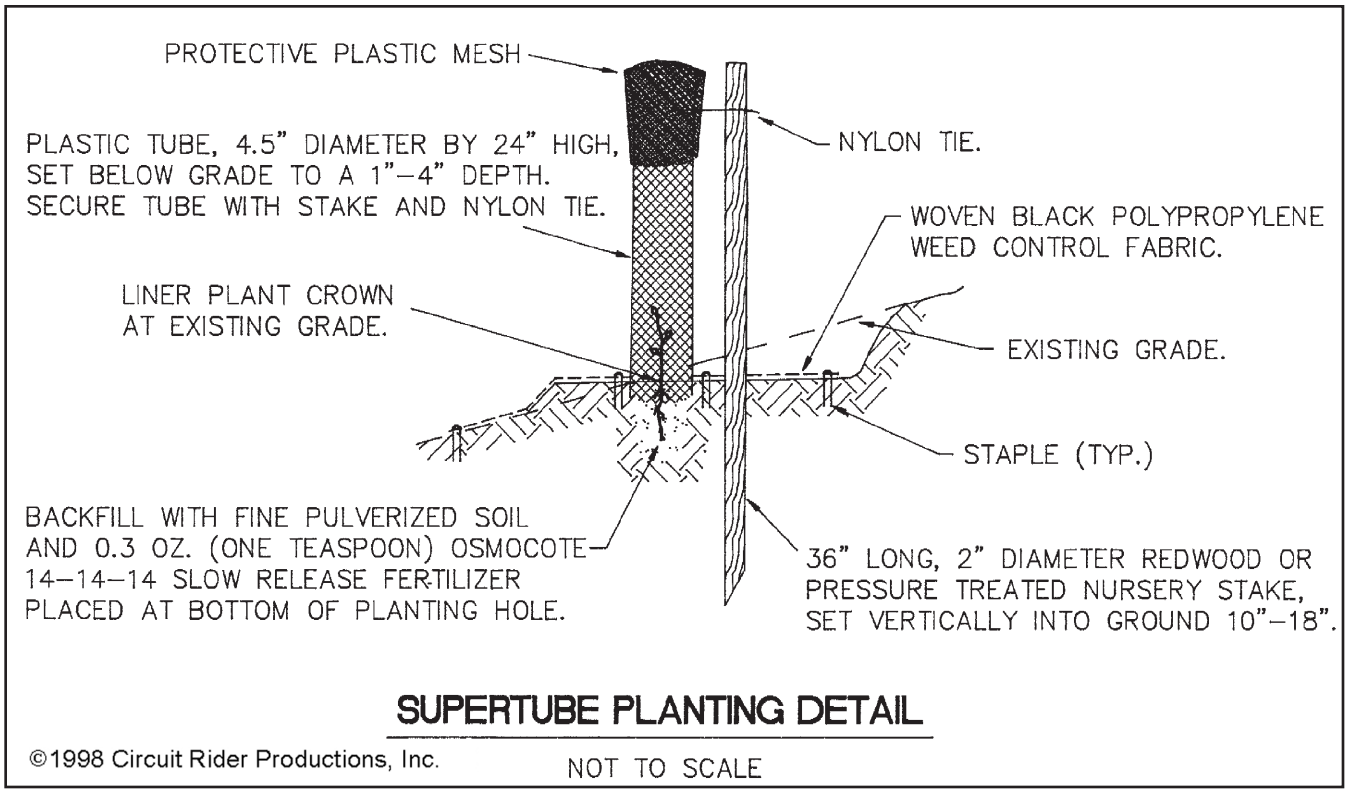


Figure 5.2 Planting detail for a widely available, relatively inexpensive method for protecting young seedlings.

Stream Bank Stabilization

Pierce's disease vegetation management projects may need special consideration for stream bank erosion problems. Because removal of host plants along streambanks can expose those banks to scouring flows, it is often necessary to integrate Pierce's disease vegetation management and stream stabilization treatments to protect vines and land.

Figure 5.3 Accelerated erosion removes native vegetation and claims valuable farmland.

Figure 5.4 This rip rap and gabion revetment on Garnett Creek was well-intentioned, but over-designed for the erosion control need.

In years past, most stream stabilization techniques used armoring of banks with rock or other hard-material revetments from the waterline to top-of-bank. This traditional method often shifts erosion to adjacent stream areas, precludes the growth of riparian vegetation and establishment of fisheries habitat, and can be very expensive.

Research in North Coastal California streams and rivers since the early 1980's has shown that alternative treatments that employ natural vegetation to protect stream banks and manage stream energy are often very effective in controlling erosion. These methods, often referred to as "bio-engineered stream stabilization techniques" use native vegetation to slow erosive water velocities, heal scour zones, and strengthen banks with root and top growth. Treatments vary widely according to stream and site conditions, but bio-engineered work typically uses little or no rock or other "hard" materials. Because it mimics natural stream healing processes and provides for restored or improved habitat, it is also preferred by most environmental permitting agencies such as the California Department of Fish and Game.

Figure 5.5 Workers install a woven willow revetment at this vineyard along Dry Creek, Napa County. This relatively inexpensive treatment provides exellent riparian habitat as well as property protection.

Consultation on these bioengineering methods is available through stream restoration experts in the private and public sector. Your local RCD /NRCS office can often provide assistance or referral to experts in your area.

Example Project Outline:
Vegetation Management Plan and Streambed Alteration Permit Notification

The following is an example project outline and timeline for producing a Pierce's Disease Vegetation Management Plan.

Background information review and collection (One year before anticipated project implmentation - in late summer)
- Initial discussions with Fish and Game and any other regulatory agencies to identify scope of project and need for Streambed Alteration Permit or other permits.
- Obtain Streambed Alteration Permit Notification forms from the Department of Fish and Game
- If desired, contact consultants who specialize in Pierce's disease revegetation projects

Mapping (Ten months to one year before anticipated project implementation - in summer or fall)
- Produce a base map of the site to use in mapping existing vegetation and to create the revegetation design plan. A map with a scale of 1"=100' is ideal for mapping site information. Aerial photos are very useful, because they show existing vegetation.
- Identify and map
    - location and density of Pierce's disease host plants to be removed
    - condition of riparian ovestory (for example: dense overstory of native trees, etc.)
    - location of existing native plants. It is useful to do a transects(s) of the stream (see p.27), identifying the location on the banks where different native plants tend to grow, to help in choosing and positioning plants for revegetation. If the site has little remaining vegetation, visit upstream and downstream areas for transect information
    - location of invasive non-native plants that may be removed (for instance *Arundo donax*)
    - sites of potential erosion and bank instability
- Include on the map the following measurements:
    - linear feet of stream and width of overall riparian area - calculate from this the area (in square feet or acres) of the riparian habitat
    - area (in square feet or acres) within the riparian habitat where host plants will be removed/revegetated, calculate the area of removal as a percent area of the total riparian habitat.
- Develop a plant list with the numbers and sizes of native plants to replace host plants removed

Revegetation Plan and Streambed Alteration Permit Notification (Six to eight months before anticipated project implementation- late fall/winter)
- Fill out Streambed Alteration Permit Notification forms
- Attach revegetation map(s) to the Permit forms, showing information listed in Mapping, above
- Attach written specifications for implementation, including:
    - methods of removing PD host plants and of installing native plants
    - timing of removal and planting - and a phasing strategy, if necessary
    - methods and timing of weed suppression, monitoring, and replacement of unsuccessful plantings
    - method of protecting eroding or unstable stream banks when PD host vegetation is removed
- Submit package to Department of Fish and Game

Obtain Plants (six months to one year in advance of planting)
- Identify plant sources: plan for propagation of local plants, and/or purchase of nursery stock

Implementation, Maintenance and Monitoring
- Wait for permits from Fish and Game and other regulatory agencies contacted before beginning work
- Begin host plant removal in late summer, and native plant installation in winter
- Maintain and monitor revegetation project for three years after installation

SECTION VI
REGULATORY AGENCIES

Several Federal, State, and local agencies have regulatory authority over work done in the riparian corridor and may need to be contacted for a Pierce's disease revegetation project. It is the landowner's responsibility to be familiar with these agencies and notify them when a project is planned. Descriptions of several agencies can be found in the following pages. A list of agency names and contact information is also included. Agencies not included in this list, such as local planning departments, may also need to be contacted.

Different agencies will have jurisdiction over a project, depending on the character or extent of the project. Most Pierce's disease revegetation projects will involve only the removal of specific Pierce's disease host plants, and replanting of native plants. Such simple revegetation projects will require the least regulatory agency input. The one agency that will certainly require notification, even for a simple Pierce's disease revegetation, is the California Department of Fish and Game. In addition, the Regional Water Quality Control Board may need notification if the vegetation removal would result in soil erosion, and/or runoff of pesticides into the stream (due to removal of a vegetative buffer).

Some Pierce's disease revegetation projects may have a stream bank stabilization component. If the stabilization involves re-contouring of the streambed and banks, the United States Army Corps of Engineers and the National Marine Fisheries Service may need notification, in addition to the two agencies mentioned above. Stream bank stabilization projects that use bio-technical approaches, such as live vegetation wattles and revetments, will have fewer negative impacts to natural resources and may need less regulatory agency involvement than projects with standard engineering and riprap. The use of standard engineering and riprap is generally discouraged in areas that contain threatened and endangered species, such as salmon and steelhead, because of the negative effects on habitat.

Formal agency notification typically involves completing a form that describes the project, often with a project design map and written description, and paying a fee. Talking to agency representatives about the project before this formal notification can save a significant amount of time. Most agencies encourage informal consultation in the early stages of project planning. The concerns of each party can be addressed, and potential roadblocks eliminated or reduced. In some cases, one agency will pass your project on for review by other agencies, but don't assume this will happen. The landowner is always responsible for informing all agencies. Many of these agencies charge fees to process the applications and permits. Please call each agency for a current fee schedule (see Agency Contact Information page 39).

Become familiar with the regulatory agencies described on the following pages. Even better, get to know the agency staff that work in your area and find out what their interests are, before you begin designing your project.

CALIFORNIA DEPARTMENT OF FISH AND GAME

All landowners must notify the Department of Fish and Game if they plan a riparian vegetation management project for Pierce's disease protection. "Notify" means that the grower must file a Streambed Alteration Permit Application, and pay a fee. Call Fish and Game to discuss the project before filing an application. During this initial discussion, Fish and Game staff may suggest changes to the planned project that will make the process go more smoothly.

The Streambed Alteration Permit application is available at the local Fish and Game headquarters, or call and it will be mailed to you. Landowners must fill out form FG 2023 – Notification of Lake or Streambed Alteration, and Form 2024 – Project Questionnaire with any necessary attachments, including project drawings. The forms and attachments should provide the following information:

- verification of incidence of Pierce's disease in the vineyard or nearby vineyards (lab test, identification by Farm Advisor or another qualified individual),
- a mapped inventory of existing vegetation, including locations of Pierce's disease host and non-host plants, and pertinent site conditions (such as areas of erosion potential). This mapped inventory should include linear feet of stream at the site and width of riparian vegetation
- a map showing selective plant removal, with estimates of the amount of vegetation, by percentage of the total, to be removed
- a revegetation plan, including number, sizes, locations of the native plant species to be used
- a written specification for plant removal and replanting, as well as a maintenance and monitoring schedule for at least three years after replanting (a brief written report will typically be required annually, detailing the installation phase and follow-up monitoring, including actions, results of follow-up, and dates)
- a description of treatments for potential erosion control or stream bank stabilization, if necessary

Provide all of the above information to avoid delays in processing the application. In some cases where significant vegetation removal is proposed the project may be phased over several years and consultation and/or oversight by a restoration specialist may be required.

The time required to obtain a Streambed Alteration Permit varies but landowners should allow at least 6 months from the time the application is submitted to the Department of Fish and Game. Streambed Alteration Permits are now subject to the California Environmental Quality Act (CEQA). To be approved, a Streambed Alteration Permit must show that the project will not cause significant environmental impact under CEQA. Once the landowner submits the application, Fish and Game staff will review the project and complete a checklist that determines the level of significance under CEQA. While filling out the checklist, if Fish and Game biologists find that fish and wildlife will be significantly impacted by the project, changes to the project will be recommended so that the impacts are reduced or mitigated. This process will take time.

In some cases a project may be so small that Fish and Game can allow it without a Streambed Alteration Permit and CEQA review, however, Fish and Game must always review the project and make the determination. These projects may involve the removal of small amounts of invasive non-native species such as periwinkle and blackberry, and replanting with native species. These projects may still require revegetation plans and three years of monitoring, as do larger projects, but they may be processed more quickly. Call the Fish and Game office to speak to staff members for more information.

Vegetation management plans for some projects may be prepared by the landowner, in consultation with the California Department of Fish and Game. Complex projects, however, may require preparation by a vegetation management specialist. Consult with Fish and Game to determine if you will need a specialist.

Additional Fish and Game Information

The Department of Fish and Game defines a stream as a body of water that flows at least periodically or intermittently through a bed or channel having banks, which supports fish or other aquatic life. This definition includes watercourses having a surface or subsurface flow that supports or has supported riparian vegetation. Many watercourses considered streams by Fish and Game are not identified as a blue line or dotted blue line streams on USGS maps. Some watercourses that were man-made may actually represent the rerouting of a natural stream and require Fish and Game notification. The best way to insure that any work in or around a watercourse will not be in violation of the Department's goals of protection of fish and wildlife resources is to contact Fish and Game.

There are many activities besides vegetation removal that require Fish and Game notification, including the following (this is not an exhaustive list, so please contact Fish and Game for more information):

- trimming or removal of vegetation (grasses, vines, shrubs and/or trees) in a creek or on its banks to control Pierce's disease, or for any other reason
- replacing an existing or installing a new culvert across a watercourse
- using equipment to remove debris or fallen trees from the bottom of a creek or on the bank
- placement of rock or other material on the bank to stabilize an eroding area
- removal of gravel or silt from a stream
- installation of new or replacement bridges or outfall pipes
- cable or trenching projects
- projects proposing to channelize a watercourse

REGIONAL WATER QUALITY CONTROL BOARD: NORTH COAST REGION, SAN FRANCISCO BAY REGION AND CENTRAL VALLEY REGION

The California Regional Water Quality Control Board is within the California Environmental Protection Agency. It is responsible for regulating pollutants to protect the water resources of designated regions in California. The North Coast Region includes lands that drain into the ocean, including northern Marin, northern Sonoma, and Mendocino counties; the San Francisco Bay Region includes lands that drain into San Francisco and San Pablo Bays, including southern Marin, southern Sonoma, Napa and Solano counties; the Central Valley Region covers inland counties draining to the Sacramento-San Joaquin Valley (including eastern Napa County). Though there are many sources of water pollution, agricultural impacts fall into what is referred to as the "non-point" category of discharges**.**

Non-point pollution comes from diffuse sources of pollutants in runoff. Sources include urban runoff, construction, agriculture, forestry, grazing, boating, and other activities. It is statewide policy to work with the owners of sites that generate non-point pollution to voluntarily solve problems. More standard regulation, such as permits and enforcement, is only done when the voluntary approach does not work.

When to Apply to the Regional Board for Approval:
Earth moving within the bed or on the banks of a stream, creek or river almost always requires a water quality permit from the Regional Board. Typically, in an agricultural setting, the use of heavy machinery within the riparian zone to change the grade, bank slope or to remove vegetation requires a water quality permit. On the other hand, the use of work crews to prune and cut plants typically does not require a permit from the Regional Board (exceptions may occur when the waterway is known to support one or more endangered species). Therefore, removing vegetation and replanting for Pierce's disease management, unless it is done with heavy equipment, typically will not need a Regional Board permit. The Regional Boards encourage vineyard managers to consult with local National Resource Conservation Service and Resource Conservation District offices for advice and guidance on vegetation management strategies.

A combined federal-state permit approval process is required for most work within the riparian zone because the waterway, including the bank vegetation, is a legally protected under the federal Clean Water Act and state Porter-Cologne Water Quality Control Act. The process for obtaining a permit to excavate or place fill in a creek is known as Section 404 permit and Section 401 State Water Quality Certification and is administered by the U.S. Army Corps of Engineers and Regional Water Quality Control Board. Depending upon the location and severity of the activity, these projects may be authorized under an existing permit that applies to the entire country ("Nationwide" 404 permits). Even in such cases, a water quality certification issued by the Regional Water Quality control Board would be necessary.

To protect Water Quality:

- Maintain a vegetated buffer, including trees, grasses and shrubs, between the vineyard and the creek. These plants filter sediment and pesticides from runoff before it gets to the water.
- Where necessary for farming operations, manage vegetation in ditches and promote natural-type drainages, rather than cleaning out and channelizing with heavy equipment.
- Stabilize problem stream banks using "biotechnical" approaches using live plants in combination with engineered structures, if necessary. Avoid use of concrete, "rip-rap" and other unnatural structures.
- Minimize use of pesticides, and fertilizers; practice integrated pest management (IPM).

NATIONAL MARINE FISHERIES SERVICE

The National Marine Fisheries Service (NMFS) is the Federal Agency responsible for the conservation and management of the nation's living marine resources. NMFS enforces the Endangered Species Act for anadromous fish (salmon and steelhead trout) in the North Coast growing region. North Coast rivers and their tributaries are under NMFS authority due to the presence of Coho salmon and Steelhead Trout.

The Endangered Species Act prohibits unauthorized "taking" of species on the Federal endangered species list. "Taking" means not only killing fish, but also includes destroying the fishes' ability to breed, feed, or utilize shelter. Examples of take include habitat damage resulting from a landslide, mudflow, or siltation caused by the landowner's actions, if the activity was unpermitted. Projects and activities that may affect anadromous fish and/or their habitat are within NMFS jurisdiction and are reviewed by the agency for any potential harmful effects, and NMFS can provide advice on habitat protection. The purpose of the review is to insure that sensitive populations of salmon or steelhead, as well as the aquatic and riparian habitat that support these fish, can survive and recover in the

presence of human activities. During review the need to conserve and protect fish and habitat is balanced with the need to responsibly utilize natural resources for economic and other purposes.

If a project has been reviewed and approved by NMFS in accordance with the Endangered Species Act, and if all required conditions are met, an authorized incidental take will not be prosecuted.

When to contact the National Marine Fisheries Service:
The types of projects and activities that are of interest to NMFS include streambank stabilization, streambed alteration, habitat restoration, culvert placement, instream dams, water diversions from creeks, flood control projects, urban and industrial development, and water resource utilization. NMFS will also consult on projects that require a federal permit, such as an Army Corps of Engineers permit. NMFS can provide technical assistance during project planning to insure anadromous fisheries protection and does not charge a fee for permits or for letters to other agencies informing them of their previous involvement. As a general guideline, projects that are developed using the principles described in "Fish Friendly Farming" literature are compatible with the needs of anadromous fish.

UNITED STATES ARMY CORPS OF ENGINEERS

As a general rule, most vegetation management for Pierce's disease will not come under the regulatory authority of the United States Army Corps of Engineers (Corps), unless the project also requires streambed or bank modification or stabilization.

Using mechanized equipment to remove vegetation within a streambed or banks may trigger the need for a Section 404 permit from the Corps if the activity will result in substantial disturbance to the alluvial bed. However, clean gravel or sand excavation that does not involve regrading or the occurrence of other discharges, does not require Corps authorization.

Under Section 404 of the Clean Water Act, the Corps has regulatory authority over the placement of fill material in all waters of the United States, including wetlands. Corps jurisdiction extends up to the ordinary high water line for non-tidal waters (usually the high water line in an "ordinary" winter storm event) and up to the line of the highest tide (in normal years) for tidal waters. If you plan to dispose of dredge material in waters or wetlands, or to fill, grade, or modify the contours of waters of the United States, you should contact the Corps. Many people are surprised by how far up into the headwaters, into small tributary streams and ponds, or even isolated, seasonally wet depressions, the "waters of the United States" extend. What may not seem like "waters of the United States" to the average lay-person, may be considered jurisdictional by the Army Corps. It is important to call the Corps to inquire.

The Corps issues different types of permits depending on the nature of the project and the size of the area impacted. The Corps will send out an applicant information pamphlet, which includes an application form and an explanation of application requirements. Many smaller projects within Corps jurisdiction will qualify for authorization under one of several Nationwide Permits, requiring only written notification to the Corps, and not formal application and approval, before work begins.

The Corps' nationwide permit verification letters require no fee. Individual permit review and authorization include a nominal fee and usually take around six months to complete, and possibly more if endangered species are involved. Almost all Corps forms of authorization require water quality certifi-

cation or waiver under Section 401, from the Regional Water Quality Control Board. Corps authorization within the Coastal Zone requires a consistency determination from the California Coastal Commission or the San Francisco Bay Conservation and Development Commission (BCDC).

COUNTY AGRICULTURAL COMMISSIONER'S OFFICE

The California Environmental Protection Agency, Department of Pesticide Regulation, administers a pesticide regulatory program to protect people, animals and the environment. The County Agricultural Commissioners have the responsibility of enforcing these laws within their respective counties.

Many agricultural pesticides require a restricted materials permit from the Agricultural Commissioner before these pesticides may be purchased or used. The Agricultural Commissioner regulates pesticide use to prevent misapplication or drift as well as direct contamination of people or the environment. The Agricultural Commissioner encourages integrated pest management (IPM) techniques to reduce the use of pesticides through the application of alternative methods of pest control. The Commissioner also enforces regulations to protect both ground and surface water from pesticide contamination.

When a grower is dealing with Pierce's disease, the use of insecticides to control the blue-green sharpshooter may be used in conjunction with other practices. Before embarking upon an insecticide program contact the Agricultural Commissioner's office in your county for information about specific pesticide labels and regulatory requirements.

Agency Contact Information:

Agency	Address	Phone	Notes/ Web Pages
California Department of Fish and Game Central Coast Region*	7329 Silverado Trail PO Box 47 Yountville, CA 94599	707-944-5500	http://www.dfg.ca.gov/wahcb.1600.html; for CEQA guidelines: http://ceres.ca.gov/planning; for F&G code: http://www.legalinfo.ca.gov/calaw.html
National Marine Fisheries Service Protected Resources Division	777 Sonoma Avenue, Room 325 Santa Rosa, CA 95404	707-575-6050	http:// www.rbc.noaa.gov;or http//www.nmfs.gov
US Army Corps of Engineers, Sacramento District Regulatory Branch**	1325 J Street Sacramento, CA 95814-2922	916-557-5250	East Napa Co. (east of the Napa River Watershed:) http://www.spk.usace.army.mil/regulatory
US Army Corps of Engineers, San Francisco District Regulatory Branch, North Section**	333 Market Street San Francisco, CA 94105-2197	415-977 8451 or 415-977-8439	Mendo., Lake, Sonoma Co. & Napa Co. within Napa River watershed; http://www.spn.usace.army.mil/regulatory
Napa County Agricultural Commissioner	1710 Soscol Ave, Suite 3 Napa, CA 94559	707-253-4357	NapaCounty http://www.co.napa.ca.us/departments/agcom/agcom.html
Sonoma County Agricultural Commissioner	2604 Ventura Ave., Rm 101 Santa Rosa, CA 95403	707-527-2371	Sonoma County http://www.sonoma-county.org
Mendocino County Agricultural Commissioner	579 Low Gap Road Ukiah, CA 95482-3745	707-463-4208	Mendocino County
Lake County Agricultural Commissioner	883 Lakeport Blvd Lakeport, CA 95453-5407	707-263-0217	Lake County
North Coast Regional Water Quality Control Board-Region 1***	5550 Skyline Blvd - Suite A Santa Rosa, CA 95403	707-576-2220 707-523-0135	Northern Marin, northern Sonoma, Mendocino counties
San Francisco Bay Regional Water Quality Control Board-Region 2***	1515 Clay Street, Suite 1400 Oakland, CA 94612	510-622-2300	Southern Marin, southern Sonoma, Napa and Solano
Central Valley Regional Water Quality Control Board-Region 5 Sacramento Office***	3443 Routier Road, Suite A Sacramento, CA 95827-3003	916-255-3000 916-255-3015	Inland counties draining to the Sacramento-San Joaquin Valley, including eastern Napa County

*The North Coast wine growing region which includes Napa, Sonoma, Lake, and Mendocino Counties is served by the Central Coast Regional Office of the Department of Fish and Game.

** Corps Districts are divided by drainage area. Sacramento District (SPK) regulates all Central California lands that drain into the Sacramento and San Joaquin Rivers. Sacramento District regulates almost all of Lake County except the area that drains into the Eel River, including Lake Pillsbury, as well as western Solano County, and western Napa County. San Francisco District (SPN) regulates all California lands that drain into the Ocean or the SF Bay.

***There are nine separate Regional Water Quality Control Boards in California. Northern California is covered by three different regions. Ask for the Regional Water Quality Control Board Watershed Management Staff assigned to your County. You may also find more information on the state's web site: www.swrcb.ca.gov.

Appendix 1

Native Plants for Riparian Revegetation Projects

This is a list of native plants for revegetation in riparian zones and the adjacent uplands in North Coast California. It is not intended to be an exhaustive or exclusive list. Not all of these plants have been extensively sampled for the blue-green sharpshooter, or *Xylella fastidiosa*. These plants are included because they are generally available in native plant nurseries and/or are reliable in riparian restoration projects. It may be helpful to work with a native plant specialist to choose the appropriate plant species and locations for your project.

Latin Name	Common Name	Tolerance			Planting Zone		
		Shade	Part Shade	Full Sun	Low bank/ Active Channel	Mid Bank/ Floodplain	Upper Bank/ Upland
Trees							
Acer macrophyllum	bigleaf maple	✓	✓	✓		✓	✓
Acer negundo	box elder		✓	✓		✓	✓
Aesculus californica	California buckeye			✓		✓	✓
Alnus rhombifolia	white alder			✓	✓		
Alnus rubra	red alder		✓	✓	✓		
Fraxinus latifolia	Oregon ash		✓	✓	✓	✓	
Juglans hindsii	black walnut		✓	✓		✓	✓
Populus fremontii	Fremont cottonwood		✓	✓		✓	
Quercus agrifolia	coast live oak			✓		✓	✓
Quercus lobata	valley oak			✓		✓	✓
Salix exigua	narrow-leafed willow			✓	✓	✓	
Salix gooddingii	Goodding's black willow			✓		✓	
Salix laevigata	red willow			✓	✓	✓	
Salix lasiolepis	arroyo willow			✓	✓	✓	
Salix lucida	shining willow			✓		✓	
Salix lutea	yellow willow			✓	✓	✓	
Salix sessilifolia	sandbar willow			✓	✓	✓	✓
Umbellularia californica	bay laurel	✓	✓	✓		✓	✓
Shrubs							
Baccharis pilularis	coyote brush			✓		✓	✓
Calycanthus occidentalis	western spice bush	✓	✓	✓		✓	✓
Cornus glabrata	brown dogwood	✓	✓			✓	
Cornus sericea	American dogwood	✓	✓			✓	
Heteromeles arbutifolia	toyon		✓	✓		✓	✓
Ribes sanguineum glutinosum	pink-flowering currant		✓			✓	✓
Rosa californica	California rose		✓	✓		✓	✓
Symphoricarpos albus	snowberry	✓	✓	✓		✓	✓

Appendix 1 (continued)
Native Plants for Riparian Revegetation Projects

Latin Name	Common Name	Tolerance			Planting Zone		
		Shade	Part Shade	Full Sun	Low bank/ Active Channel	Mid Bank/ Floodplain	Upper Bank/ Upland
Herbaceous Perennials							
Achillea millefolium	yarrow			✓		✓	✓
Aquilegia formosa	columbine	✓	✓			✓	✓
Aristolochia californica	pipevine	✓	✓				✓
Iris douglasiana	Douglas iris	✓	✓	✓			✓
Lonicera hispidula	honeysuckle	✓	✓				✓
Lonicera involucrata	twinberry	✓	✓				✓
Polystichum munitum	sword fern	✓	✓	✓			✓
Scrophularia californica	bee plant			✓			✓
Grasses, Sedges, Rushes							
Bromus carinatus	California brome		✓	✓			✓
Carex barbarae	whiteroot Santa Barbara sedge	✓	✓	✓		✓	✓
Carex nudata	torrent sedge	✓	✓		✓		
Elymus glaucus	blue wildrye		✓	✓		✓	✓
Festuca rubra	red fescue		✓	✓		✓	✓
Hordeum brachyantherum	meadow barley			✓		✓	✓
Juncus balticus	baltic rush		✓	✓		✓	✓
Leymus triticoides	creeping wildrye			✓		✓	✓
Melica californica	California melic	✓	✓			✓	✓
Nassela pulchra	purple needle grass			✓		✓	✓

Appendix 2
Resources

Information about this Manual

Please address questions about this manual to Ellie Insley, who can put you in touch with other members of the project team if desired, at 707-933-0509.

This Manual can be obtained at no charge in Napa, Sonoma, Mendocino and Lake Counties at local Resource Conservation District; Natural Resources Conservation Service; or UC Cooperative Extension offices (listed below). The North Coast Pierce's Disease Task Force will have additional Manuals, if you are unable to pick them up locally. Please call the Task Force at 707-259-1500 x 127 (Martin Mochizuki). The Manual can also be accessed at the following web site: http://www.CNR.Berkeley.EDU/xylella/north/info.htm

Local Resource Agencies

The following local resource agencies can provide more information or referrals. For California State and Federal regulatory agencies, see page 39.

Region	Agency	Address	Phone
State of California	California Department of Fish and Game Central Coast Region	7329 Silverado Trail PO Box 47 Yountville, CA 94599	707-944-5500
Napa County	Agricultural Commissioner	1701 Soscol Ave, Suite 3 Napa, CA 94559	707-253-4357
	Napa County Resource Conservation District	1303 Jefferson St. Suite 500B Napa, CA 94558	707-252-4188
	University of California Cooperative Extension	1701 Soscol Ave, Suite 4 Napa, CA 94559	707-253-4221
	USDA/Natural Resources Conservation Service - Phill Blake	1303 Jefferson St. Suite 500B Napa, CA 94558	707-252-4189
Sonoma County	Agricultural Commissioner	2604 Ventura Ave. Santa Rosa, CA 95403	707-527-2371
	Goldridge Resource Conservation District	874 Gravenstein Hwy. Sebastobol, CA 95406	707-823-3037
	Sotoyome Resource Conservation District	970 Piner Road Santa Rosa, CA 95406	707-569-1448
	Southern Sonoma Resource Conservation District	1301 Redwood Hwy. Suite 170 Petaluma, CA 94954	707-794-1242
	University of California Cooperative Extension	2601 Ventura Ave. Santa Rosa, CA 95403	707-527-2621
	USDA - Natural Resources Conservation Service	1301 Redwood Hwy. Suite 170 Petaluma, CA 94954	707-794-1242

Mendocino County	Agricultural Commissioner	579 Low Gap Road Ukiah, CA 95482-3745	707-463-4208
	Resource Conservation District	405 Orchard Ave. Ukiah, CA 95482	707-468-9223 ext. 5
	University of California Cooperative Extension	579 Low Gap Road Ukiah, CA 95482	707-463-4495
	USDA/Natural Resources Conservation Service	405 Orchard Ave. Ukiah, CA 95482	707-468-9223
Lake County	Lake County Agricultural Commissioner	883 Lakeport Blvd. Lakeport, CA 95453-5407	707-263-0217
	East Lake and West Lake Resource Conservation District	889 Lakeport Blvd. Lakeport, CA 95453	707-263-4180
	University of California Cooperative Extension	883 Lakeport Blvd. Lakeport, CA 95453	707-263-0217
	USDA/Natural Resources Conservation Service – Len Kashuba	889 Lakeport Blvd. Lakeport, CA	707-263-4180

Websites:

Native Plants and Pest Plants

www.ipm.ucdavis.edu/PMG/selectnewpest.home.html
UC Davis Pest Management Guidelines

http://www.ca.blm.gov/caso/weeds.html
California Noxious Weed Coordinating Committee

http://www.caleppc.org
This is the web site for the California Environmental Pest Plant Council.

http://www.cnps.org
This is the web site for the California Native Plant Society

Pierce's Disease - Blue-green sharpshooter

http://www.cnr.berkeley.edu/xylella/index.html
The *Xylella fastidiosa* web site, managed by UC Berkeley professor Dr. Alexander Purcell, contains considerable information about Pierce's disease and other disorders caused by *Xylella* bacteria.

Pierce's Disease - Glassy-winged sharpshooter

http://danrcs.ucdavis.edu/
UC's Communications Services web site has a section specifically on glassy-winged sharp-shooters. It includes recent UC publications (with images) as well as highlights of ongoing UC research.

http://plant.cdfa.ca.gov/gwss/
The California Department of Food and
Agriculture's glassy-winged sharpshooter site includes the insect's current distribution in California, an updated host plant list and additional regulatory information.

http://ucceventura.xlrn.ucsb.edu
For this site, click on "Commercial Agriculture", and then click on "Integrated Pest Management (IPM)". Several articles on Glassy-winged sharpshooter are listed on the left of the screen.

Resource Conservation - General
www.nrcs.usda.gov/
This is the national web page for the USDA/Natural Resources Conservation Service.

www.nrcs.usda.gov/techres.html
This is the technical resources section of the USDA/Natural Resources Conservation Service web site. You will find information on stream bank stabilization and erosion control techniques. The document Stream Corridor Restoration: Principles, Processes and Practices, is available online at this site.

http://www.sercal.org
This is the web site for the California Society for Ecological Restoration.

Sustainable Agriculture and Integrated Pest Management
www.napanet.net/~nswg/homepage.htm
This is the web page for the Napa Sustainable Winegrowing Group, and can provide further information on Integrated Pest Management and Sustainable Winegrowing for the North Coast Region.

Books and Publications:
Native Plants
Note: the UC Cooperative Extension – Sonoma County is developing a local riparian plant book with color photos. Please contact them for more information.

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Circuit Rider Productions, Inc. 2000. A Guide to Restoring Native Riparian Habitat in the Russian River Watershed. Circuit Rider Productions, Inc., 9619 Old Redwood Highway, Windsor, California 95492.

Chestnut, V.K. 1974. Plants Used by the Indians of Mendocino County, California. Mendocino County Historical Society, Publication Headquarters, 243 West Bush Street, Fort Bragg, California, 95437.

Faber, Phyllis M. and Holland, Robert F. 1982. Common Riparian Plants of California: A Field Guide for the Layman. Pickleweed Press, 212 Del Casa, Mill Valley, California, 94941.

Goodrich, Jennie; Lawson, Claudia; and, Parrish Lawson, Vana. 1980. Kashaya Pomo Plants. Heyday Books, Berkeley, California.

Hickman, James C., ed. 1993. The Jepson Manual: Higher Plants of California. University of California Press, Berkeley and Los Angeles, California.

McMinn, Howard E. 1974. An Illustrated Manual of California Shrubs. University of California Press, Berkeley and Los Angeles, California.

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Martin, Alexander C.; Zim, Herbert S.; and, Nelson, Arnold L. 1961. American Wildlife & Plants: A Guide to Wildlife Food Habits. Dover Publications, Inc., 180 Varick Street, New York, New York, 10014.

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The Federal Interagency Stream Restoration Working Group, 1998. Stream Corridor Restoration.

Warner, Richard E. and Hendrix, Kathleen M. 1984. California Riparian Systems - Ecology, Conservation, and Productive Management. University of California Press, Berkeley and Los Angeles, California.

Integrated Pest Management and Pierce's disease

An article on PD with color illustrations of vectors and symptoms is in Grape Pest Management, 2nd Edition.1992 University of California, Division of Agriculture and Natural Resources Oakland, CA

Nursery Sources - Native Plants for Restoration Projects

California Conservation Corps – Napa County
P.O. Box 7199
Napa State Hospital (corner of Elder and Madrone)
Napa, CA 94558
707-253-7783

Circuit Rider Productions, Inc.- California Native Plants Nursery
9615 Old Redwood Highway
Windsor, CA 95492
707-838-6641

Pacific Open Space/North Coast Native Nursery
P.O. Box 744
Petaluma, CA 94953
707-769-1213

Cornflower Farms
P.O. Box 896
Elk Grove, CA 95759
916-689-1015

Developing and Implementing a Pierce's Disease/Riparian Vegetation Management Plan

by

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May 2001

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This document is an addendum to the ***Information Manual: Riparian Vegetation Management for PD in North Coast California Vineyards***

by

The Pierce's Disease/Riparian Habitat Workgroup

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Introduction

This document outlines the procedure for preparing and submitting a Streambed Alteration Permit Notification to the California Department of Fish and Game (abbreviated in this Addendum as Fish and Game) for a Pierce's disease revegetation project. Pierce's disease (PD) revegetation projects include removal of plants that host *Xylella fastidiosa* bacteria and the blue-green sharpshooter, and subsequent revegetation with native, non-host plants. This information should be useful for vineyard managers who plan to undertake such a project.

This document is an **Addendum** to the *Information Manual: Riparian Vegetation Management for Pierce's Disease in North Coast Vineyards*, a publication of the Pierce's Disease/Riparian Habitat Workgroup (September, 2000[2]). Please read the *Information Manual* first, and keep the two documents together. This Addendum assumes an understanding of topics introduced in the *Information Manual*.

Revegetation projects can be complex and require significant advance planning. They also require a familiarity with native plants and riparian ecology, to tailor the revegetation design to the unique characteristics of the site. Some projects include stream bank stabilization, and expertise in hydrology and engineering may be essential. Also, Fish and Game requirements for project design and documentation are considerable (the Department must conduct CEQA - California Environmental Quality Act - review on all its Streambed Alteration Permit projects). In order to coordinate the input from consultants and meet the requirements of Fish and Game, the planning and design process should begin at least one year before planned host plant removal and revegetation. A revegetation project involves:

- Assessing the complexity and potential impacts of the project
- Mapping the site to produce a complete inventory of existing conditions
- Conducting any necessary design calculations for projects that include bank stabilization (i.e. hydrology or engineering calculations).
- Designing a revegetation plan
- Producing a written project description and set of specifications for removal, replanting and maintenance that satisfies Fish and Game requirements.
- Removal of PD host plants after a permit has been issued
- Replanting with native non-PD host plants
- Maintenance and monitoring for three years after the last phase of planting is completed
- Annual monitoring reports submitted to Fish and Game during the maintenance period

[2] The *Information Manual* is available at UC Cooperative Extension offices, USDA/Natural Resource Conservation Service offices, or Resource Conservation District offices in Napa, Sonoma, Lake and Mendocino Counties, and at **http://www.CNR.Berkeley.EDU/xylella/north/info.htm**.

Section A: Consultations with the California Department of Fish and Game

Begin initial communications with Fish and Game *at least* one year before you plan to begin the actual revegetation. Request a preliminary site visit with a Fish and Game representative familiar with the Streambed Alteration Permit process for PD revegetation projects. This will help you produce a plan that better addresses biological concerns or issues you may have otherwise overlooked.

The following questions can be addressed during this site visit:

- Is a Streambed Alteration Permit Notification required (i.e., is the site within Fish and Game jurisdiction?)
- Do other regulatory agencies have jurisdiction in this project?
- Is the project large enough that phasing is recommended?

Assessing the complexity of a site

a. How significant are the impacts on wildlife of the proposed revegetation project? The revegetation project will have the least impact on wildlife if the site has a well-developed riparian habitat, and if small patches of host plants will be removed and replaced with non-host species. On the other hand, the project may have significant impacts on wildlife if the site has few trees, but is covered with host species such as *vinca* (periwinkle) and blackberry. When these plants are removed, a significant amount of habitat may be affected. It could take years for newly planted species to colonize the area and provide habitat.

b. How large is the project?

In general, linear, narrow stretches of stream less than 500 feet long and 50 feet wide, with uniform streambank conditions are the least complex. Sites larger than this are usually considered complex sites by Fish and Game. You may want to consider dividing larger projects into smaller sub-projects and phase implementation to reduce impacts to wildlife. (see Phasing large projects, below).

c. Will adjacent habitats remain for wildlife?

Dense stands of riparian vegetation adjacent to the project area can provide refuge for birds, amphibians, and mammals once the project is underway. Examples include revegetation work done on one side of the stream, leaving the opposite bank untouched for a later phase; contiguous neighboring property where no removal will take place; or phasing the project, leaving large islands of vegetation untouched until later phases are implemented.

d. Are additional stream modifications being proposed?

Other modifications such as bank stabilization or a stream crossing will increase the complexity of the proposal. This type of modification may require engineered designs and detailed surveys.

Phasing large projects

If a project is particularly large and complex, phasing it over two to three years is recommended to minimize the impacts on wildlife. One option is a "leapfrogging" technique in which the entire area is broken down into several smaller areas. In the first year, host plant removal and revegetation is completed in non-adjacent areas, leaving the habitat between areas intact for at least one year.

Speeding approval

To help expedite a project, Fish and Game recommends beginning the planning process in summer the year before planned implementation, and submitting the completed application in the Fall. The workload for processing permit applications is lightest in winter, and projects may move more quickly at that time. Also, be sure to include all of the elements listed in the section "Creating /Submitting a Revegetation Plan", Section D below.

Timing of removal, planting, and weed control

It is Fish and Game policy to minimize disturbance in riparian areas during wildlife breeding seasons from March 1 through July 15. Therefore, no removal of host species is permitted during this time. The optimal time for planting is in winter, when the ground is saturated.

Table 1. Appropriate timing for revegetation in riparian areas

ACTIVITY		**TIMING**
Pierce's Disease host plant removal (includes use of mechanical equipment such as weed-eaters as well as herbicides)		July 15 - December 15
Planting		Anytime (the best time to plant is in winter after the ground is saturated)
Weed control	*-mechanical (using weed-whackers)*	July 15 – December 15
	-hand/chemical	Year-round (March 1- July 15)

Section B: Consultations with Restoration Specialists

The grower or vineyard manager may hire a restoration specialist to design and oversee all or part of the project. An experienced restoration specialist can provide valuable knowledge of native riparian plants appropriate for your site, and determine how long it will take to design, permit, install and monitor the project including time necessary for phasing.

For larger projects Fish and Game may require design by a restoration specialist. In addition, Fish and Game typically requires that a restoration specialist oversee host plant removal and revegetation, monitor the project during the three year maintenance phase, and provide a yearly progress report. A restoration specialist should also be skilled in assessing the need for bank stabilization measures. If bank stabilization is necessary, a hydrologist with experience in bio-engineering

techniques should be consulted. Restoration specialists can provide the following skills and services:

- Inventory/map the site
- Develop a phasing plan to minimize impacts
- Write a revegetation plan with specifications for location, spacing and numbers of site-appropriate plants.
- Write a maintenance and monitoring plan
- Assess the project for bank instability – and recommend follow-up by a hydrologist/engineer
- Provide oversight during installation, monitor the project and provide annual progress reports during the maintenance phase

In Napa County, and possibly in other counties, the Natural Resources Conservation Service (NRCS) may be available to provide the hydrology/engineering services and bio-engineering design, or can recommend a consultant. The Napa County NRCS can also help with the revegetation design on smaller projects, or can work with a private restoration specialist on larger projects.

Check references before hiring any consultant and contact your local NRCS office to learn what consultants commonly work in your region. A restoration specialist should demonstrate successful experience in similar projects, and a hydrologist/engineer should have a good track record with bio-engineering projects.

Section C: Field Work and Mapping

Taking inventory of the site – gathering and mapping information about vegetation and stream channel conditions – is the first step in producing a revegetation design. This inventory map will be the foundation for producing written specifications for the removal and revegetation plan. This inventory should be done in summer, when deciduous plants are in full leaf.

A significant amount of information will be recorded on your map. Therefore, the map should be large enough to provide room for legible notes. A scale of 1 inch = 100 ft. is recommended but 1inch =200 ft. is acceptable on larger sites. Unless you already have a map of your area at that scale, you will have to create one. See the Appendix for information on creating a base map.

Taking Inventory

Tools for gathering site inventory include: the base map; an engineer's scale that matches the scale of the map (such as 1"=100'); a measuring wheel or tape (at least 200' long); a camera with print film. Appendix II illustrates a sample inventory map.

a. Initial measurements

Starting at the beginning of the PD revegetation site, use a measuring wheel or tape to measure the entire length of the riparian area in which vegetation will be

removed. Mark the property and your map at 50 ft. or 100 ft. intervals, from the beginning to the end of the proposed revegetation area. These intervals can be marked on the site with flagging. Also measure the width of the riparian habitat – from the edge of the riparian vegetation on one side, across the creek to the edge of riparian vegetation on the opposite side – at several representative locations, and determine an average width.

b. Map landmarks

Identify and map distinctive objects such as large trees, a significant bend in the stream, or a log across the stream. These objects will help with orientation when you visit the site later.

c. Measure and map Pierce's disease host plants to be removed

- *location* - using the measuring wheel (or 200' measuring tape) and the map scale, plot the masses of host vegetation on your map where they occur along the stream and on the bank: *banktop, midbank or lower bank*.
- *size* - plot the plant mass to scale on the map and record the size as well (i.e. "Himalayan blackberry 10x25 ft.").
- *density* – estimate the density of the patch of host plants as *light*, *medium*, *or dense,* by estimating how much ground is visible underneath the host vegetation, and therefore how much cover it provides for wildlife.

d. Measure and map existing native shrubs.

- *location and size* of native shrub masses should be recorded as outlined above in item **c.**

e. Map existing riparian tree masses and sun/shade availability

- *location* – plot the tree masses on the map, and note any large masses of a single tree species (in many cases the tree masses are mixed species).
- *Sun/shade* – estimate the amount of shade provided by the tree canopy in each of the removal/replant areas: sunny, filtered sun, or dense shade. This information will help determine the appropriate plants for revegetation, since some tolerate more sun or shade than others. This step must be done in summer.

f. Measure and map non-native invasive plants, such as Arundo donax* (giant reed) *or eucalyptus seedlings

- *location and size* should be recorded as outlined above in item **c**

g. Measure and map stream bank condition

- *channel* – sketch the location of the low-flow channel (the deepest point of the stream) as you map, noting significant turns, pools, etc.
- *bank instability* – map the location of unstable banks, particularly if removal/replant areas occur on or nearby these unstable points

h. Sketch transects

A transect is a pictorial representation of a section of the stream, similar to a cross-section. It will illustrate the slope of the bank, the location on the bank of the removal/replant area, and the location on the bank of various plant species (see Appendix II). Sketch a transect at least every 500' or when there are significant changes in the stream bank or vegetation.

1. Draw a line on the map at the transect location, perpendicular to the stream and extending from the vineyard edge, across the stream to the opposite side of the bank. Label this line "Transect 1".
2. On the map (or on a separate piece of paper) sketch the shape of the channel and stream banks along the transect line. Label this sketch "Transect 1" as well.
3. On this transect sketch, draw trees and shrubs where they grow on the bank, and label them by species. It is important to include the edge of the vineyard, showing the distance from the top of bank to the first vines. Indicate whether the vine rows are perpendicular or parallel to the channel.
4. Record the following measurements on the transect:
   - distance from vineyard edge to top of bank
   - width of the patches of host plant species to be removed
   - width of banktop, midbank, and lower bank, where applicable
   - estimate depth of channel, and vertical drop of cut banks, where applicable

i. Take photographs

Take photographs at the transect locations, and at any other place that captures important information about the site, such as areas with bare understory, areas with dense blackberry, or areas with dense non-host native shrubs. Areas with distinct bank or stream conditions, such as a terrace or a cut bank, can also be photographed. Include in the photo a familiar object or person to indicate scale.

Record on your map the following information about the photo (see Appendix II):

- Mark the location of the photo
- Indicate the direction of the photo with an arrow
- Indicate the number of the photo in sequence, as well as the exposure number
- If there is room, note what you intended to capture on film – dense canopy, minimal understory, cut bank, etc.

Section D: Creating/Submitting a Revegetation Plan

<u>Obtaining the Streambed Alteration Permit Notification forms</u>

Contact the Fish and Game office in Yountville (707-944-5500) for a copy of the Streambed Alteration Permit Notification forms, which include "Notification of Lake or Streambed Alteration" (FG 2023) and "Project Questionnaire" (FG 2024). Carefully read the packet, particularly the "Instructions and Procedures" pages, which explain how to fill out the forms. Answer each question on the forms.

h. Sketch transects

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Project description and specifications, and other attachments

In addition to filling out the forms (FG 2023 and 2024), you must provide attachments that include a project description, a map of the project, and written specifications describing how the project will be implemented.

The following components should be included in the Project Description and Specifications. Most of this information you will have gathered during the inventory and mapping phase. **Include the following information with your Application to help expedite approval of the project.**

a. General Project Description (1-2 sentences for each):

1. Purpose of the project: i.e. Pierce's disease revegetation project – removal of Pierce's disease host plants and revegetation with native non-host species. Note that Pierce's disease has been verified on the site.
2. Timing of the project: i.e. beginning date – when plants will be removed and when revegetation will be completed. Discuss phasing if necessary.
3. Specifically name those plants to be removed, and name the non-host plants to be used in revegetation.
4. Area of riparian habitat at the project site (square feet): state the length and average width of the riparian habitat, including both sides of the stream and multiply to get the area.
5. Area of disturbance (square feet): add together the size of each individual removal/replant area for the total disturbed area.
6. Percent of the site that will be disturbed when host species are removed: calculate this percentage by dividing the sum of the removal/replant areas by the area of the entire riparian habitat (4 & 5 above).
7. Overall description of the vegetation on the site: include dominant plant species, other species and approximate abundance (dense or sparse), of both native and non-native plants; note whether or not the stream is perennial (flowing all year).
8. Other aspects of the project besides Pierce's disease revegetation: i.e. bank stabilization, or removal of invasive non-native plants such as *Arundo donax* (giant reed), if appropriate.

b. Description of removal/replant areas

In four or five sentences, describe in detail each individual removal/replant area (if you have more than one). Include:

1. Size of removal/replant area (length, width and area) and host plant species composition (for example, 10'x 25'= 250ft^2 of which 50% is Himalayan blackberry, 50% is periwinkle; or 100% Himalayan blackberry)
2. If the patch of host species is mixed with desirable species such as snowberry, the description would be: 10'x 25'= 250ft^2 of which 75% is Himalayan blackberry, 25% is snowberry (to be protected during blackberry removal)
3. Tree species, maturity and density
4. Streambank condition (eroded, stable, etc.)
5. Other undesirable plant species that may be removed (giant reed, eucalyptus)

c. Specifications for Host Plant Removal, Revegetation, Irrigation and Maintenance

Include the following information in your specifications. See pages 23-30, and 40-41 of the *Information Manual* for additional detail)

Selective Host Plant Removal

- Methods for protecting native plants before beginning work (i.e. train workers in plant identification, mark with flagging examples of plants to be protected)
- Tools and techniques for host plant removal

Planting/Irrigation

- Source and size of plants for revegetation (see Section E: **Obtaining plants**, below)
- Detailed plant list, including numbers of each plant for each area
- Spacing of plants
- Methods of planting
- Method of irrigation

Maintenance and Success Criteria (required for a three year period after all planting is completed)

- Methods and timing for weed control
- Method and timing for irrigation maintenance
- Success criteria (i.e. what percent of the plants will survive? Replanting will be required when the success rate falls below this percentage)
- Individual responsible for monitoring the project and timing of submitting progress reports.

Plant List and Site Map (see Appendix III) and Photographs

- Attach a Plant List, including numbers of plants by species for each area and total plants to be used
- Attach a map of the site that clearly shows the location and size of the replant areas
- Include a “locator map”, which can be copied from road map, with the site clearly marked in relation to local roads and towns.
- Include an aerial photo, if available (optional but very useful).
- Choose several representative photographs to attach with clear, concise descriptions.

Revegetation transects

- Include one or two transect sketches, to illustrate the shape of the stream channel, the overstory, and the location on the bank of the host species. Also note where on the bank the revegetation will occur.

Revegetation plan checklist

- ❑ project description and written specifications
- ❑ photographs
- ❑ site map with replant areas, locator map
- ❑ plant list, with numbers of plants by species for each replant area
- ❑ revegetation transects

Section E: Obtaining plants

Begin the process of obtaining plants as soon as your permit has been approved, preferably six months to one year before planting. Plants propagated from seed or cuttings collected locally will be best suited for your site. Several nurseries specialize in this type of work. Their contact information appears in Appendix 2, page 46 of the *Information Manual*. Call these native plant sources for price estimates and availability.

Section F: Timeline

- Initial consultations with Fish and Game and revegetation specialists –
  begin in late spring/early summer
- Mapping –
  1-4 weeks, depending on the size and complexity of your site, and the time available; begin in summer
- Preparing Streambed Alteration Permit Notification forms and attachments
  1-4 weeks, depending on complexity of site; begin in late summer/fall
- Processing application
  1-6 months depending on size and complexity of site; fall-winter
- Purchasing plants/Collecting for propagation
  At least six months in advance
- Identifying/Protecting native plants
  Summer, before removal begins
- Host vegetation removal
  1-3 months, depending on site; summer to mid-fall
- Planting
  2 weeks-several months, depending on site and plant availability (you may wait several months for some plants to be available ; mid-fall to end of winter
- Irrigation system installation
  begin in spring immediately following planting
- Maintenance
  3 year minimum; after all planting is complete

Thus, for a project that began with a Fish and Game consultation in July of 2001, design and permitting could be complete by early summer 2002. Vegetation removal could then begin in July 2002, and revegetation could begin in November 2002. The project would be maintained and monitored until November 2005, at which time the plantings should be self-sufficient.

Appendix I: Creating a base map

The purpose of this exercise is to create an accurate base map in the scale desired so that the plant inventory can be taken.

Materials:
Measuring wheel or tape (at least 200'); aerial photograph that shows tree canopy and major landmarks; engineer's scale

Measurements:
1) Measure in the field using a measuring wheel or tape – Choose a distance of 700 feet or more if possible, straight and level, marked easily on the photograph; and in the middle of the photograph (a vineyard row or road works well). These suggestions provide the most accurate measurement and account for possible distortion in the photo.
2) Mark starting and ending points of field measurement on aerial photo
3) Use engineers scale to measure distance between starting and ending points on aerial photo at desired scale (1"=100' or 1" =200')
4) Divide field measurement by scale measurement
   Multiply by 100 to get a percentage. Enlarging the aerial photo by this percentage will generate a base map at the desired scale (1"=100' or 1" = 200').

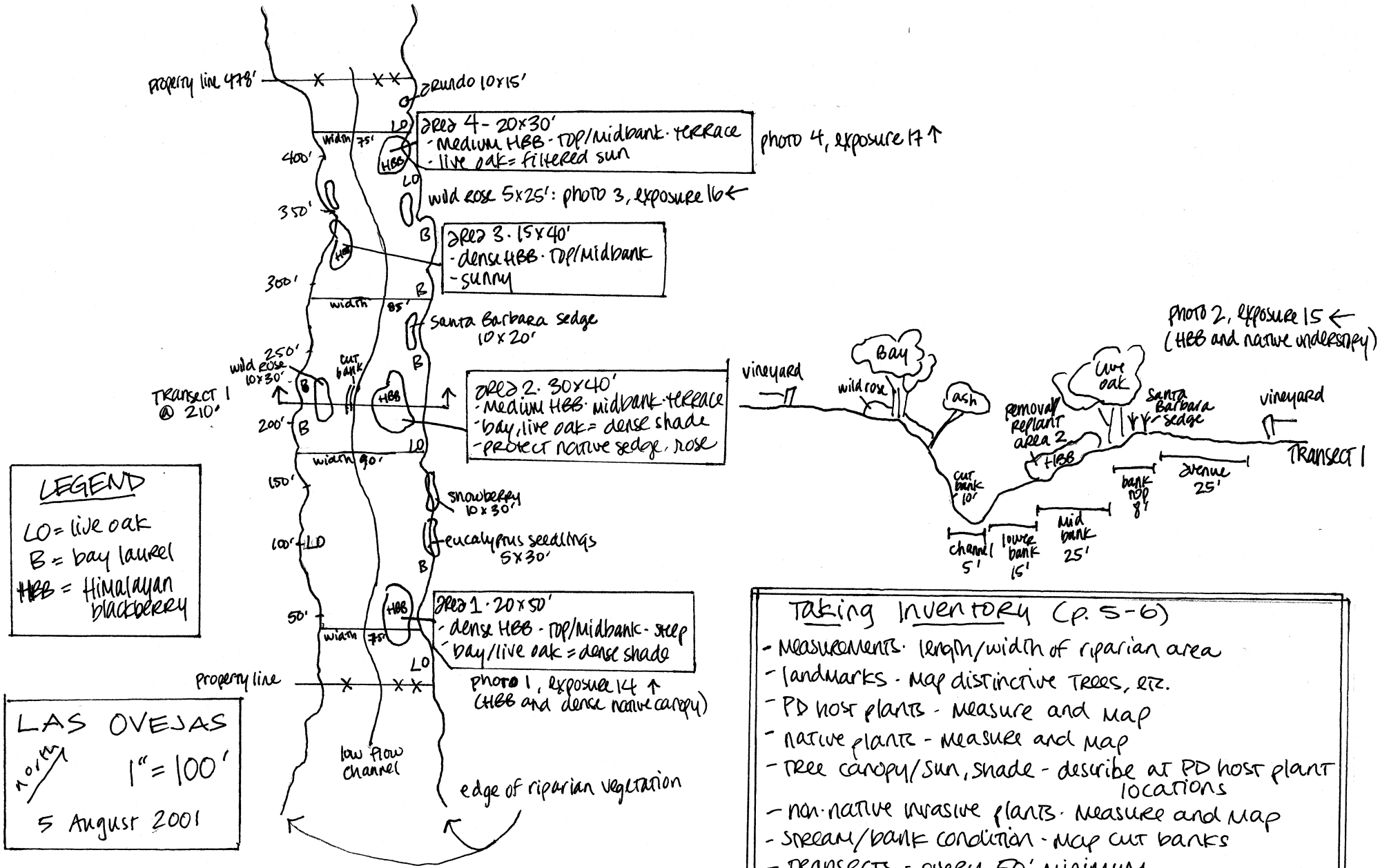
Example:
1) your wheel measurement in the field is 746 feet.
2) the distance on the aerial photo that represents the wheel measurement is 368.8'.
3) divide by the wheel measurement: 746' / 368.8' = 2.02
4) multiply by 100: 2.02 * 100 = 202

Thus, to be converted into a map with a scale of 1" = 100', this aerial photo needs to be enlarged by 202%. This enlargement would make sense if the scale of the aerial is 1" = ± 200'.

Blank calculations to fill in:
- wheel measurement _____
- engineer's scale measurement _____
- wheel measurement divided by scale measurement ____ /____ = _____
- multiplied by 100 ____* 100 = _____ **final percentage**

Enlarge the map at a copy service that has up-to-date copy machines with the capacity to enlarge to the decimal place if necessary, and can create a "screened" or "half-toned" image. Without this half-tone capacity, the copy of the aerial photo will be illegible.

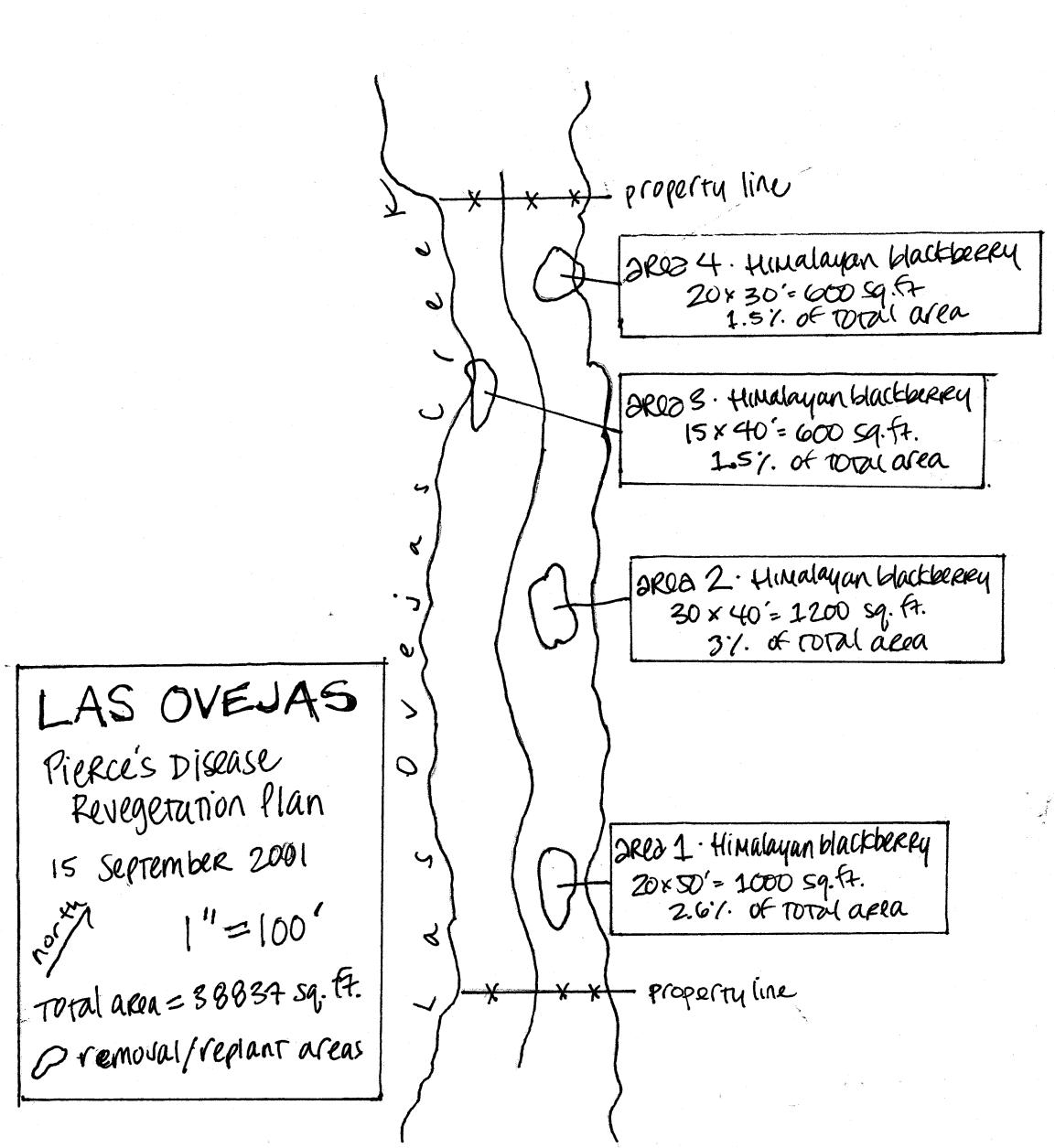
Finally, on your new map, write the location or project name, the map scale, and a north arrow for orientation.



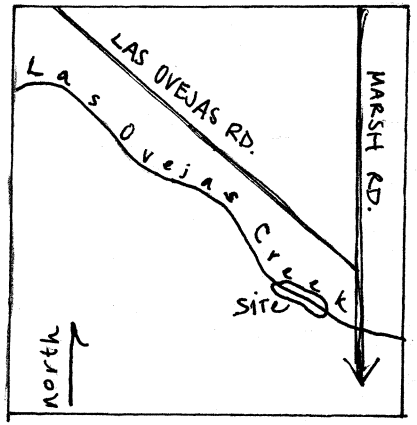
Taking Inventory (p. 5-6)

- Measurements · length/width of riparian area
- landmarks - Map distinctive trees, etc.
- PD host plants - measure and map
- native plants - measure and map
- Tree canopy/sun, shade - describe at PD host plant locations
- non-native invasive plants · Measure and map
- Stream/bank condition - Map cut banks
- Transects - every 50' minimum
- photographs - at every transect

APPENDIX II Sample field map with plant inventory checklist



LOCATOR MAP



LAS OVEJAS PLANT LIST

LATIN NAME	COMMON NAME	Area 1	Area 2	Area 3	Area 4	TOTALS
Trees						
Total Trees						
Large Shrubs						
Total large shrubs						
Medium shrubs						
Total medium shrubs						
Grass/sedge plugs						
Total plugs						

* fill in species and plant numbers according to site *

APPENDIX III Sample site map and plant list to be enclosed with fish and Game application