Chapter 3

DEVELOPMENT IN CONTRA COSTA COUNTY RIPARIAN AREAS: IMPACTS OF STREAM CHANNELIZATION

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> *"One of the most recent threats to natural streams is that of channelization. The dredging and straightening of streams is converting hundreds of miles of meandering productive fish-filled streams into sterile, unattractive drainage ditches."*
>
> --Smith, 1974

Introduction

For many centuries now, humans have altered stream channels for various reasons. This activity, known as channelization, includes any type of modification of the natural stream channel. As populations increase in certain areas there is increasing pressure on these habitats, and many natural characteristics of streams, such as occasional flooding, become urban problems. These water-associated habitats are attractive targets for development of office buildings, restaurants, entertainment areas and housing developments. They are attractive due to their aesthetic value, and tend to increase the value of a development project. Creekside habitat alteration has occurred at a rapid rate in Contra Costa County, where development has increased dramatically over the past decade.

This study will examine various types of channel modifications and their possible impacts on the aquatic and terrestrial fauna associated with this sensitive habitat. The regional focus of this paper will contrast channelized sections of Walnut Creek as it flows through the cities of Concord and Walnut Creek in Contra Costa County (A, B, Figure 1a). I will compare and contrast these channelized zones with a natural stream section along Cache Creek in Lake County, California (C, Figure 1b).

Past Studies

The majority of the available information on channelization emphasizes the biotic components of projects. These include studies by Benke and others (1979), Fredrickson (1979), Schmal and Sanders (1978), and Tyler and others (1980). Studies that consider impacts on the chemical and physical environment include Brice (1981), Brown and others (1981), and Stern and Stern (1980). "Before and after" studies are fairly uncommon. However, one such study compared the conditions of Bull Creek in Pennsylvania before and after a transportation project (Cooper, 1981, 1983). The two culverts constructed in this project proved successful at reducing channelization impacts on the fish population.

Simpson and others (1982) detail the laws and regulations that govern channelization activities. Their legislative history, dating back to the 1950's, provides a good chronological record of the growing concern for the treatment of stream waters in the United States.

Background and Description of Channelization

It has been estimated that as of 1964, 70% of the 3.2 million miles of riparian habitat in the United States had been either altered or lost (Simpson et al., 1982). In some areas 95% of this resource has been impacted. These alterations have an immense potential for impacts on the physical, chemical, and biological components of riparian ecosystems (Simpson et al., 1982).

Channel modifications are classified into two main categories. One type, called short-reach channelization, is associated with projects such as highway, logging road and railroad bridge construction. The other type, long-reach channelization, is Contra Costa County's main threat, because it consumes large portions of stream habitat for agricultural and urban development (Simpson et al., 1982).

Channel modifications include clearing or snagging, riprapping, widening, deepening, realignment, and lining (Simpson et al., 1982). Clearing or snagging is the process of removal of obstacles from within the stream channel, such as bedload material, debris, logs and vegetation. The use of rock or other material in certain parts of the channel to reduce erosion is called riprapping. Widening is the increase of the channel width in order to increase the stream capacity. The decrease in elevation of the channel floor is called deepening and is done in order to increase water capacity, decrease the water table or provide for greater drainage capability. Realignment, the construction of a new channel or the straightening of the original one, is performed to control the channel direction or to increase the channel capacity. Depending on the stream gradient, this method can have detrimental physical impacts, as will be seen later. One of the most harmful activities to the aquatic biota is the process of lining; this entails the placement of a synthetic layer between the water and the bank substrate to increase capacity, decrease erosion and/or conserve water.

Natural Stream Components

The ecology of the stream environment, like that of other environments, is very dependent on its level of diversity. High diversity ensures that each species can utilize a habitat that meets its personal requirements. The following paragraphs will examine various components of natural systems that are the "guarantees" of diversity for these ecosystems. Without these essential components, high diversity will generally not be assured.

Aquatic vegetation is a major component of stream diversity (Figure 2). Hynes (1970) showed the importance of this plant growth for the attachment of microinvertebrates. The vegetation types of a stream can determine the total species composition of an area. The plants play a major role in the production of oxygen and provide sites for egg laying within the stream channel. Survival of immature and small fish is dependent on growth of aquatic vegetation, which fish utilize as cover from larger predatory fish.

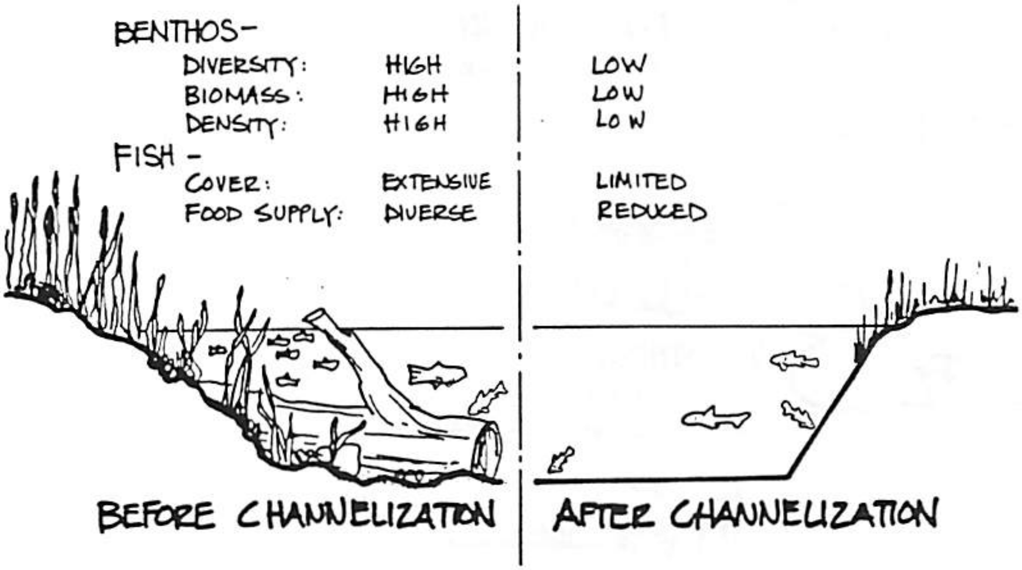

Figure 2. Comparison of diversity and cover in channelized and unchannelized sections. The loss of snags and instream and streamside vegetation is a classic result of a typical channelization project.

Source: Simpson et al., 1982.

Streamside vegetation (Figure 2) provides cover from predatory birds and solar heating (Gerking, 1959), and it provides habitat for terrestrial fauna, including insects. The vegetation helps to stabilize the stream bank by binding the soil with root growth. Streamside vegetation also provides input to the channel in the form of detritus and snags (Egglishaw, 1964) as the bank is undercut.

Undercut banks (Figure 3) provide cover for stream biota and ensure a constant input of solid cover such as snags and tree trunks into the channel. This process is often a reason for channelization in areas where human structures are potential subjects for undercutting (Simpson et al., 1982). We will see that often it is this effect that leads to demands for channel modifications in urban areas.

A unique and delicate stream component is the riffle-pool sequence. It is dependent on many variables, and so is easily impacted (Leopold et al., 1964). Each pool and riffle zone is a distinctly different habitat, providing for a variety of species. The sequence helps maintain good vertical structure of the streambed for varying depths. Riffle zones are areas of high oxygen production due to the tumbling action of the water. They provide substrate and cover for many fish species, especially those with high oxygen requirements. Trout fishermen quickly learn that trout prefer the

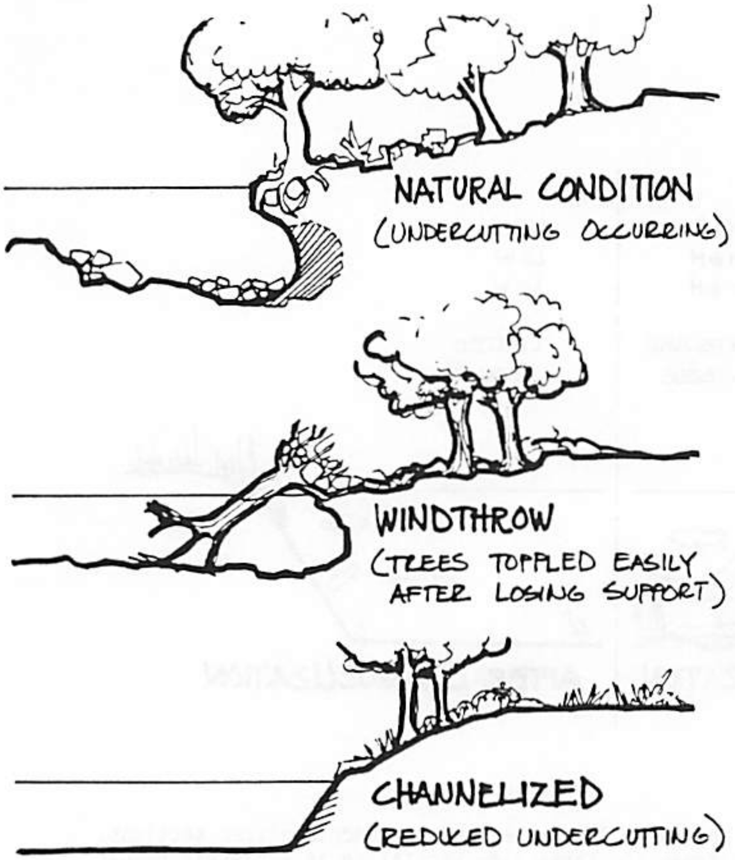

Figure 3. The natural process of undercutting and windthrow at the channel edge compared to a channelized section. Consider the potential for fish cover and habitat due to this process.

Source: Simpson et al., 1982.

high oxygen riffle zones. Riffles and pools are also important to aquatic insect life. Larval forms attach to rocks of the riffles, whereas burrowing forms can be found in the pools. The sequence also plays a major role in fish distribution. Riffles divide the stream into sections and tend to distribute the biota evenly (Simpson et al., 1982).

The meandering pattern of streams, called sinuosity, is the ratio of actual stream length to the linear distance covered. It is a function of gradient, water velocity and substrate. Due to the eroding power of higher gradient streams, they are less dependent on bedrock for their meander pattern and have generally straight channels with a low sinuosity ratio. Lowland streams can have very high sinuosity ratios. Good sinuosity provides a greater amount habitat space (Figure 4). Streams of higher sinuosity will hold a larger water volume and provide a longer travel time of stream waters for better reaeration and purification functions.

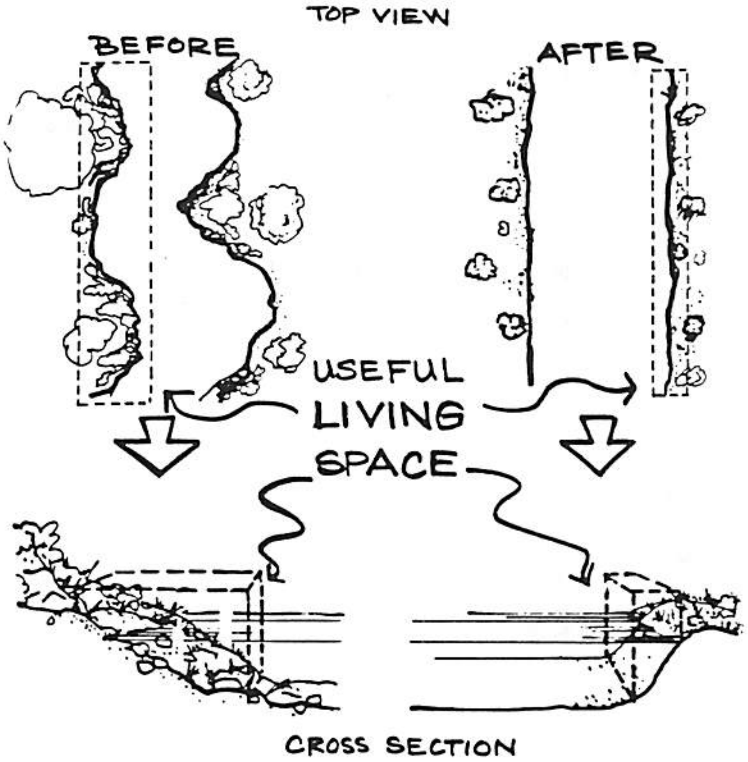

Figure 4. The space advantage of sinuosity in a natural channel and the reduction in living space a straightened channel can produce.

Source: Simpson *et al*., 1982.

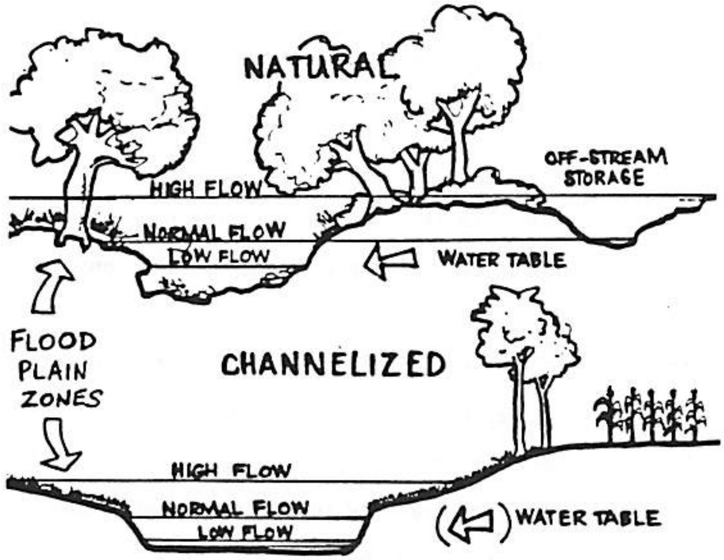

Figure 5. The loss of offstream storage areas due to channelization. Notice the loss of vertical structure in the channelized section.

Source: Simpson *et al*., 1982.

Effects of Channel Modification

Research on the incompatibility of channelization and stream diversity shows that there tend to be a general decrease in diversity and productivity in channelized areas (Patrick, 1973) and permanent species changes (Workman, 1965). Fish food loss is a common result of clearing vegetation and simplifying ecosystems (Figure 6) (Mortensen, 1977). In larger river systems, such as the Missouri River, catches are significantly lower along channelized sections than along natural areas (Groen and Schmulback, 1978). Significant decreases in upper trophic level populations have been noted because of less cover for lower trophic levels to utilize (Figure 7).

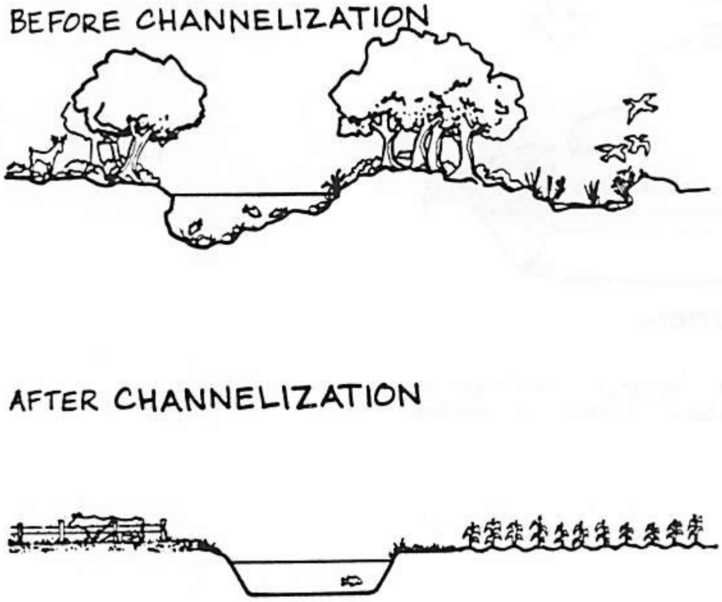

Figure 6. Vegetative clearing and the simplification of the ecosystem due to channelization for agriculture. Notice the loss of vertical structure of the channel floor and the susceptibility of the channel to excessive solar heating.

Source: Simpson _et al_., 1982.

Study Areas and Comparisons

Cache Creek (Figure 1, Plate 1) was chosen for this study because it is a natural stream environment with all the components of diversity previously described. A visit to such an environment can truly display the difference these simply components can create. The water is crystal clear within the serene pool zones and foamy white as it tumbles over the riffles. Fish swim slowly within the pools, mostly moving along the heavily vegetated stream banks. They often rest under submerged tree stumps and eroded rocks that stick out from the banks like well-designed aquatic rooftops. The area is rich in wildlife. Deer, coyotes, birds, squirrels, frogs, watersnakes, waterfowl and even beavers can be seen there in abundance. The sandy banks are filled with mazes of footprints of the many animals which depend on this vital habitat. The magic of areas such as this can never be described adequately, but needs to be experienced personally. What would be the cost of building such a paradise from scratch? Do we even know how?

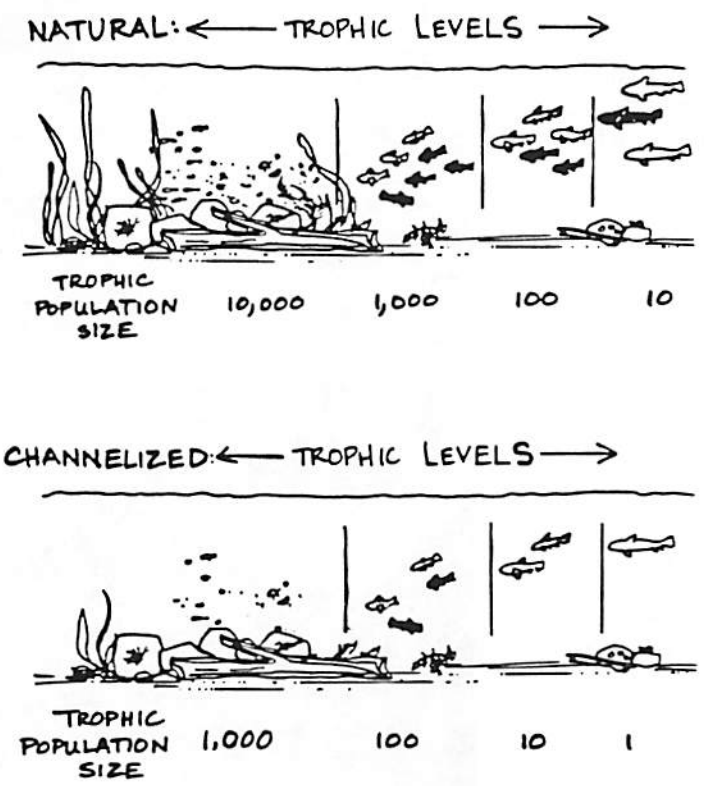

Figure 7. The decrease in population size at different trophic levels between a natural and channelized stream. Notice that in the highest trophic level each fish represents the presence of 1,000 fish of the lowest trophic level.

Source: Simpson et al., 1982.

After examining the Cache Creek habitat, I began a comparison with two sections of Walnut Creek (Figure 1). The Walnut Creek stream system passes through two Contra Costa cities, Walnut Creek and Concord, which are planned quite differently in relation to the creek. In the city of Walnut Creek, the urban environment reaches to the very edge of the creek channel, hosting miles of houses, apartments, condominiums and office buildings. With the proximity of this development, the natural stream undercutting causes a demand that artificial linings be installed for erosion and flood control. Much of this work was done by the Sacramento District of the U.S. Army Corps of Engineers. Their work began over fifteen years ago, and projects are still taking place today. Bank linings in the area include rock, cement (Plate 2), wood, iron and steel. This activity completely detaches the aquatic and terrestrial components of the ecosystem. With reduced erosion, instream cover from undercut bank erosion is greatly reduced. Many sections are culverted through underground pipes and cement enclosures and lack the input of sunlight that is so essential to life. Decaying portions of former

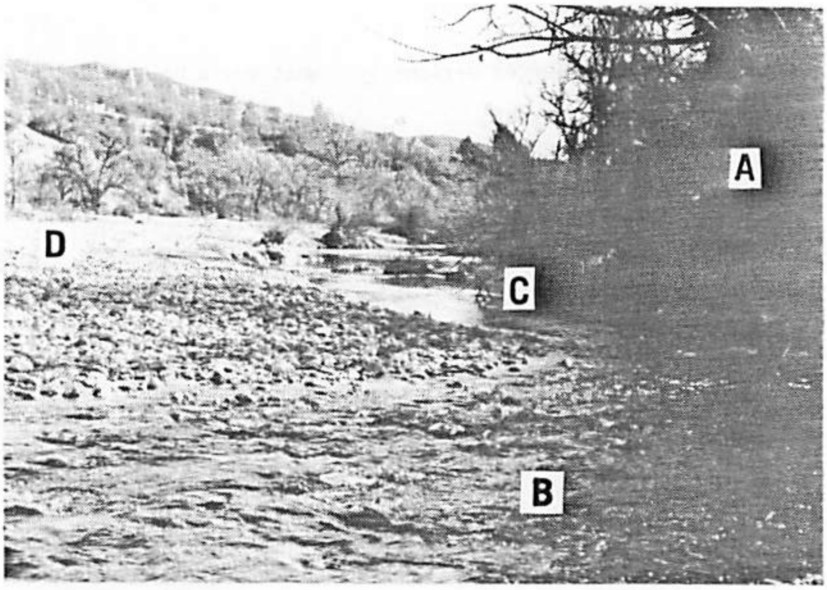

PLATE 1

Cache Creek
(Lake County, CA)

Natural stream channel. Notice the streamside vegetation(A), riffle(B) and pool(C) zones, wide flood plain(D) and good sinuosity.

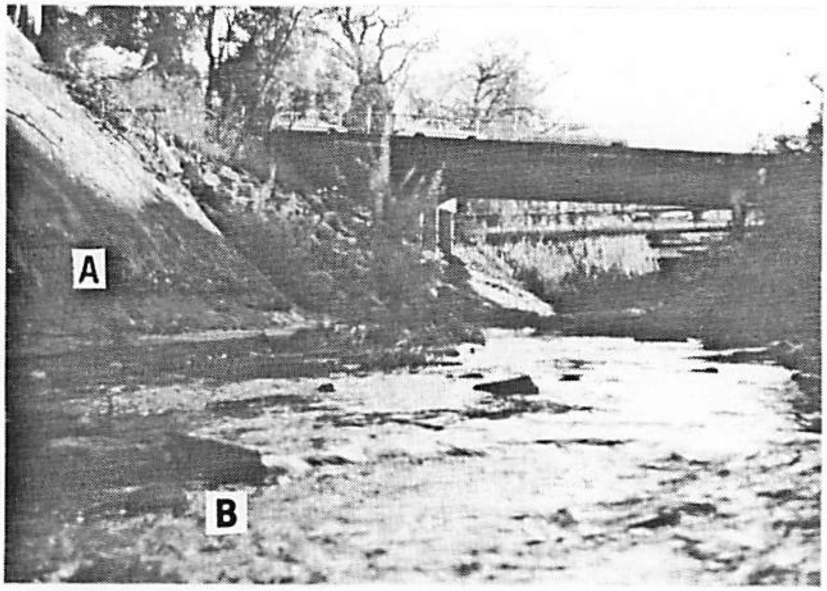

PLATE 2

Walnut Creek
(Walnut Creek, CA)

Channelized stream section. Notice the absence of many of the components listed above. Also notice synthetic linings(A)(i.e. concrete) and decayed sections of former linings within the stream channel(B).

PLATE 3

Walnut Creek
(Concord, CA)

Channelized stream section. Notice the streamside vegetation, aquatic vegetation, wide flood plain and good sinuosity.

artificial liners tumble into the creek channel, and the water is odorous. Aquatic vegetation is at very low levels, for many of the channels are no longer exposed to sunlight. The riffle-pool sequence has nearly been eliminated. Sinuosity has also been reduced, with the straightening of many channels causing reduced habitat space, especially in areas where the stream has been culverted. No one fishes; no children run around with buckets in pursuit of crayfish or bullfrogs.

This does not have to be the destiny of a modified stream if modifications are designed properly. In Concord, a few miles north of the city of Walnut Creek, the channel habitat is a major contrast. This section is also channelized (Plate 3). However, the developments (houses, apartments) are positioned at greater distances from the main channel. This allows for preservation of a flood plain, which provides a large capacity for water during heavy rains and also provides for vital habitat for many bird species. Egrets can be seen searching the muddy pools and shallow channels for food. Rocks have been placed along the upper banks of the flood plain to reduce erosion. The impacts of this riprapping appear minimal because the water only occasionally contacts these zones during its highest stages. The vegetation of the flood plain is different from the adjacent urban vegetation; it survives flooding and drought situations. Footprints of small mammal species are seen in abundance. The floodplain has good vertical structure, and the channel displays a good riffle-pool sequence. Fish, crawfish and aquatic vegetation thrive within these waters, and fishing is a popular pastime. Anglers of all ages can be found south of the Willow Pass Road overpass adjacent to Highway 242 (formerly 24). Fishing is good there and even resident rainbow trout are caught.

From an ecosystem viewpoint, these two sections of Walnut Creek differ immensely. They both represent channelized sections of the same creek in a very rapidly growing area of Contra Costa County; yet one is an ecological success and the other a failure. The goal of this study is not to criticize these projects, but rather to show that with proper thought and early urban planning, we can engineer channelization projects ecologically to be well-functioning and productive habitats.

Conclusion

Knowledge we have gained about the treatment of stream resources offers potential benefit for future developments. New methods of channelization are now being employed. In recent years, minimal straightening of channels has been practiced (Nelson and Weaver, 1981) and ideas of promoting stability with trees and imitating the natural morphology have been accepted (Nunnally, 1978). Bulkey and others (1976) showed in Iowa that if ecological considerations are incorporated into the plans of a project, fish habitat can remain stable or even be improved.

Presently, restoration of Wildcat Creek in Richmond, California is in progress (Williams, pers. comm., 1987). The value of the natural steelhead run, which was a characteristic of that creek before channelization, has been identified. In an attempt to re-establish the run, activities there include the removal of many channelization structures to revive the ecology of the system. Even industry has cooperated in this effort. Chevron Corporation, a major oil producer in this area, has agreed to relocate an outfall from their plant to reduce interference with the steelhead migrations. Hopefully, such actions are a dawning of new concerns for the value of these sensitive ecosystems.

To give stream resources the respect they deserve, a new point of view is clearly needed. Humans need to look at creeks, both urban and rural, as habitats for a full range of aquatic and terrestrial life, rather than as simple water carriers. They offer an immense potential for recreation, production and beauty to any area. If we are to develop areas along stream channels, let us employ sound ecological practices to help preserve the benefits these ecosystems can offer us.

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