Assessment of Moat Creek Fisheries and Prospects for Restoration

Prepared for: **Moat Creek Management Agency**
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Executive Summary

Moat Creek is a small coastal stream flowing into the Pacific Ocean just south of Point Arena. A fisheries resources assessment was conducted to determine whether the creek had completely recovered from the impacts of a bentonite spill that occurred in August 1992 and to determine what measures might be implemented to improve and restore salmon or steelhead runs. While the stream has fully recovered from spill impacts, it seems that Moat Creek never supported salmonids because of natural geologic conditions in the watershed. However, a very diverse amphibian population is indicative of restored stream health. The goal of restoring or improving salmonids in Moat Creek proved infeasible; therefore, an alternative proximate watershed is recommended for expenditure of funds dedicated to fisheries restoration. Moat Creek could still serve as an interesting natural history study site for local schools.

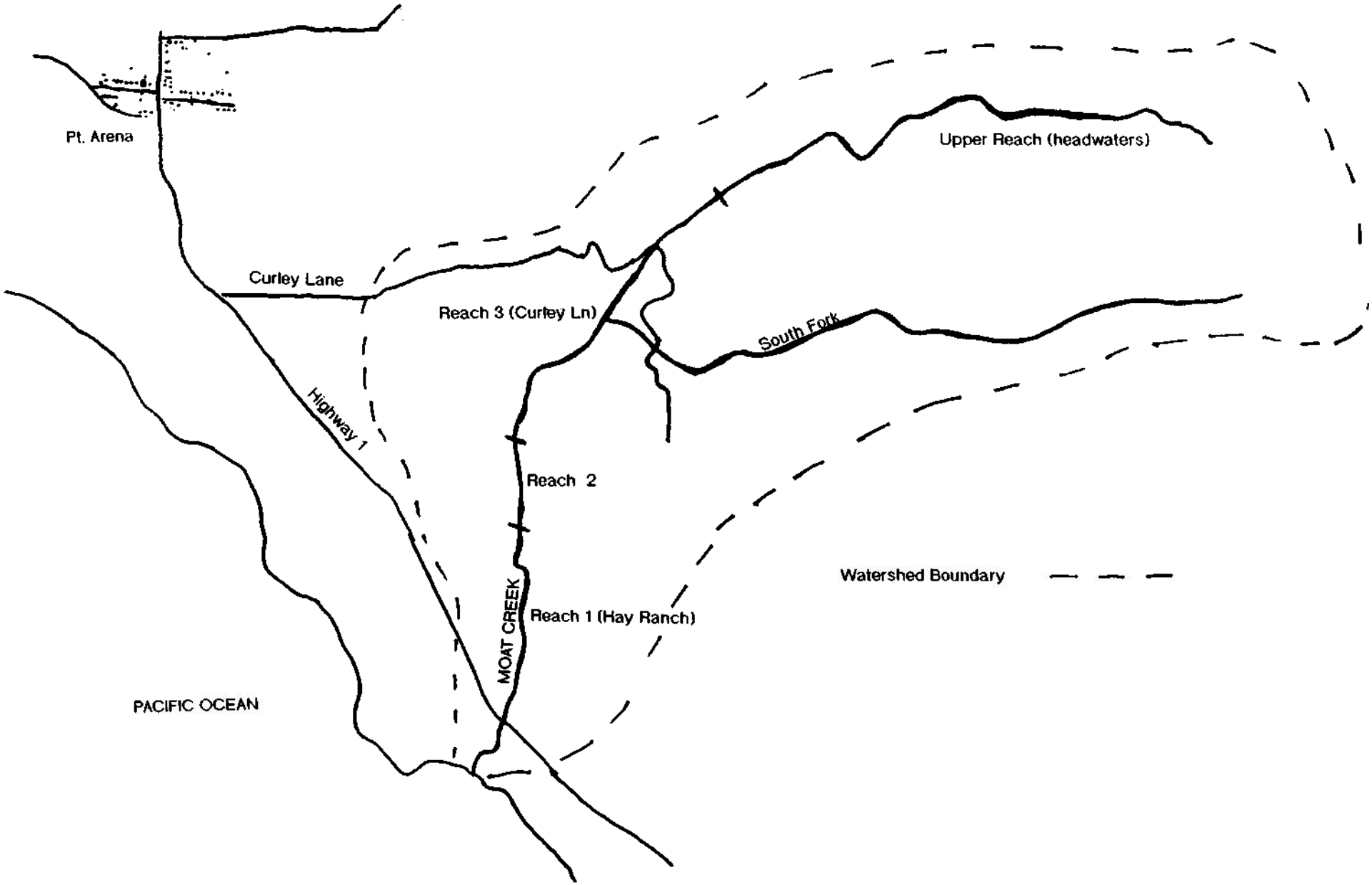
Introduction

In August 1993 a field assessment of Moat Creek was conducted to determine the status of fisheries and other aquatic resources in Moat Creek, a second order stream that flows into the Pacific Ocean just south of Point Arena. The stream was the site of a bentonite spill in August 1992 (Higgins, 1992) and study objectives included assessment of recovery from spill impacts and determination of restoration measures to help restore coho salmon (Oncorhynchus kisutch) and steelhead (O. mykiss) populations in the basin, if possible. A geologic investigation of the watershed was subsequently conducted in November 1993.

The headwaters of Moat Creek arise in the Coast Range about three miles inland. The basin area is just under three square miles and the maximum elevation in the watershed is about 1,000 feet. While rainfall occurs mostly between October and May, aquifers in headwater areas feed small amounts of cool water into the stream during dry periods. Stream temperatures were measured at 53° F in headwater areas, while lower reaches and the lagoon were 60° and 62° F, respectively. Surface flow may be lost in some portions of the stream during prolonged periods of dry weather but aquatic life is retained in pool habitats.

Moat Creek can be logically divided into four reaches: steep headwaters, a low gradient reach in the vicinity of Curly Lane, a short higher gradient reach, above the Hay Ranch, and the flat, alluvial reach in agricultural land that extends about one mile to the ocean (Figure 1). The South Fork of Moat Creek was not surveyed but would constitute a fifth stream reach. The canopy of the stream is quite dense in most reaches with coastal redwood and Douglas fir shading upper reaches and red alder and willow dominating the riparian of milder gradient reaches. Silk tassel,

Figure 1. Moat Creek watershed map showing reaches and key locations



sword fern and bracken fern provide most of the ground cover under the riparian tree canopy. The stream bed in the upper reach has course stream bed materials, such as cobbles and gravel. The lower reaches have only sparse gravels and often the stream bottom is clay.

Methods

Fish and other vertebrate fauna were collected by electroshocking and identified in the field on August 5, 1993. The fisheries survey was conducted with the assistance of California Department of Fish and Game staff Rick Macedo and Ed Ramos, as well as Craig Bell, the Garcia River restoration coordinator. Reaches surveyed included the lagoon, Moat Creek at Highway 1, above and below the Curly Lane bridge and the upper reaches of the creek above and below the site of the bentonite spill.

Stream channel conditions were evaluated by walking more than a mile of Moat Creek on August 6, 1993 to determine what factors might be limiting salmonid production and to assess restoration potential. Yarrow Brucker, a restoration specialist with New Growth Forestry, assisted in this exercise. Danny Hagans, an Earth scientist with Pacific Watershed Associates, visited the Moat Creek watershed on November 5, 1993 to help gain understanding of the relationship between geologic conditions and lack of salmon and steelhead. The geologic map used for watershed assessment was entitled Geology *and Geomorphic Features Related to Landsliding, Point Arena 7.5' Quadrangle, Mendocino, California* (Davenport, 1984) .

Fisheries Investigations

On August 5, 1993, fisheries of Moat Creek were assessed using electrofishing. The survey began in the lagoon of Moat Creek where numerous threespined stickleback (Gasterosteous aculeatus) were collected (Photo #1). This species can live anadromously and has a wide range of tolerance to temperature and dissolved oxygen (McGinnis, 1984) . Threespined stickleback and red-legged frogs (Rana aurora) were also collected in Moat Creek where it crosses under Highway 1. The water temperature was measured at 60° F, which is suitable for salmon and steelhead, but none of these fish were found.

The next reach electroshocked was above and below the bridge at Curly Lane. A rough-skinned newt (Taricha granulosa) was captured and both red-legged and yellow-legged frogs (Rana boylei) were also present. The water temperature was 59° F but salmonids were absent. While there was complete overhead cover from a dense canopy and some cover elements in the stream, it was noted that the particle size distribution of the stream bottom did not appear suitable for

salmon or steelhead. The creek flowed in a clay bed with only a thin veneer of pea gravel in places.

In the upper reach surveyed, above and below the 1992 spill site, the water temperature was 57° F. Moat Creek is incised in a narrow gorge in this reach and has approximately a 4% gradient. The stream bed is made up of predominantly course bed materials, including cobble and gravel (Photo #2). Very high densities of Pacific giant salamanders (Dicamptodon ensatus) were found during the survey. Three age classes seemed to be represented, with numerous two-inch long specimens, some four-inch long larvae and a few adults (8") that had retained gills and remained aquatic (Photo #3) . Adult Pacific giant salamanders are usually terrestrial. Almost no trace of the spill was evident anywhere in the stream channel. No juvenile steelhead or rainbow trout were found in this upper reach despite a reported sighting just after the spill (Higgins, 1992). Discussions with Rick Macedo and Ed Ramos led to the conclusion that temporary CDFG personnel had made the report and had most likely mistaken a large Pacific giant salamander for a resident trout. A more extensive electrofishing survey of this stream reach in 1992 by Weldon Jones, a California Department of Fish and Game Biologist, also found no salmonids.

The conclusion from the fisheries survey was that there are no salmon, steelhead or resident trout present in Moat Creek at this time nor is it likely that any were present at the time of the bentonite spill.

Assessment of Recovery From Bentonite Spill Impacts

Every reach of the stream channel surveyed seemed to have fully recovered from impacts of the August 1992 spill and following clean up efforts. Almost no trace of bentonite could be found in the vicinity of the spill site or anywhere in the channel below. One minor exception was that some non-native sandy materials were found on terraces next to log-jam removal sites. These materials were stored above the active channel and pose absolutely no threat to any aquatic resources. Stream clean up efforts, as shown in Photo #4, do not seem to have disturbed riparian root structure or otherwise caused any damage. **All actions taken in Moat Creek by** AT&T **to limit damage from the spill** seem **to have been appropriate and to have prevented any long term damage to aquatic resources in the stream.**

Determining Stream Conditions Limiting Salmonid Production

An extensive survey of Moat Creek was conducted on August 6, 1993 to try to determine limiting factors for salmon and steelhead production. Although another objective of this exercise was to assess restoration potential, decisions on that topic had to be deferred.

The fisheries survey conducted the day before had shown a total absence of salmonids in Moat Creek, yet many habitat parameters for salmon and steelhead seemed to be met. The entire stream had water temperatures suitable for salmonids, ranging from 53° F at the headwaters to 62° F in the lagoon. The cool temperatures are maintained because of a completely closed canopy over the stream along its entire course. The healthy riparian understory would also provide filter capacity to prevent fine sediment from entering the stream from any disturbance in upland areas. Under cut banks, woody plants growing along the stream margins and downed trees would provide cover for juvenile salmonids, were they present in Moat Creek. After walking a substantial portion of the stream, we came to the conclusion that lack of gravel in the stream bed would prevent spawning success in most reaches.

All lower reaches of Moat Creek were either clay bottomed or had a thin layer of pea gravel overlying clay (Photo #). A small amount of cobble and gravel was found in terraces, above sites where log jams had been removed down stream of Curly Lane. The jams had formerly served to trap these course bed materials but also fine sediment. No appropriate site for salmon or steelhead spawning was available throughout the lowest 1.75 miles of the stream. Coho salmon are not able to access steeper reaches of small streams, so the lack of spawning substrate in low gradient reaches of Moat Creek near the ocean would make the stream unsuitable for them.

The bed of Moat Creek in the upper reach is composed of bedrock, boulders, cobble and gravel, all of a uniform orange sandstone. The stream side rocks were covered with mosses to a level about four inches above summer base flow levels (Photo #2). The lack of scour on stream side rocks indicated that fluctuations in flow are moderate even during winter storms. It is likely that the healthy watershed conditions that prevail in upper Moat Creek moderate rapid peaks in stream flow even during intense rainfall. While it appears that substrate composition here might allow for salmonid production, the small size of the stream in this headwater area might preclude successful steelhead spawning. Native rainbow trout also occur frequently in coastal streams but are absent from in Moat Creek. One explanation for their absence could be that they may have been out-competed by Pacific giant salamanders.

During the August 6 field tour, it was noted that the stream appeared to be down cut in the reach below Curly Lane by somewhere between 15-20 feet. Pea gravels in a linear pattern were embedded in stream banks a few feet above current stream flow which also suggested down cutting. Denuded banks at an old access for stock watering led to a hypothesis that grazing practices during times of early settlement might have triggered down-cutting.

Several questions were raised regarding the stream bed condition of Moat Creek that required the opinion of an experienced geologist:

* What is responsible for lack of spawning gravels in the lower reaches of Moat Creek?
* Is stream down-cutting a natural phenomenon or human induced?
* Is down-cutting related to lack of salmonids?
* Is there any cost-effective treatment that could be implemented to create spawning areas?

Relationship of Watershed Geology to Salmonid Production

On November 5, 1993, a geologic assessment of Moat Creek was conducted to aid in analysis of factors limiting salmonid production. An examination of a geologic map (Davenport, 1984) showed the watershed is completely lacking in any well consolidated bedrock materials (Figure 2). The parent material in the basin is almost exclusively weakly consolidated marine materials which weather rapidly. Also apparent in the geologic maps are numerous traces of faults within the Moat Creek watershed which probably have some bearing on stream down cutting.

There are only four different rock formations that under-lie the Moat Creek basin: marine terrace deposits, the Galloway-Schooner Gulch formation, the German-Rancho formation and the Monterey group. The marine terrace deposits are composed of poorly to moderately consolidated marine silts, sands and quartz rich pea gravels and the Galloway-Schooner Gulch formation is moderately consolidated sandstone (Davenport, 1984). The German-Rancho formation has moderately hard, coarse grained sandstones interbedded with mudstone and less common conglomerate. While the Monterey group has some well consolidated, porcelaneous shale and siltstone, it also is composed of softer sandstone, siltstone and sandy mudstone (Davenport, 1984).

Slates, shales, siltstones and mudstones are not only soft but often have bedding characteristics that causes the materials to erode in sheets. These plate-like clasts do not transform into rounded cobbles and gravels when weathered in a stream environment. The more well consolidated sandstones in the watershed do become rounded as they wash downstream but they usually have weak bedding planes which causes them to break down (Photo #5). This explains in part why coarse bed materials were present in headwaters of Moat Creek while lacking in lower reaches; the rocks simply disintegrate as they tumble downstream. The quartz-rich pea gravels of the marine terrace deposits are really the only truly hard rock in the basin; therefore, it is not surprising that they are often the only armoring seen in lower reaches of the stream.

The 1906 Earthquake caused 11 feet of uplift at Manchester, just north of Point Arena. Danny Hagans said that Moat Creek is likely to have experienced similar uplift during major movements of the

Figure 2. Moat Creek geologic map (Davenport,1984)

Pgr German Rancho Formation: Moderately hard sandstones, mudstones and less common conglomerate

Mmy Monterey Group: Well consolidated porcelaneous shale and siltstone with weaker sandstone,siltstone and mudstone

Mgs Galloway/Schooner Gl Formation: Moderately consolidated sandstone

Qmts Marine Terrace Deposits: Poorly to moderately consolidated silts, sands and quartz rich pea gravels

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San Andreas. It was his professional opinion that **the down-cutting of the stream is happening in response to tectonic uplift and that Moat Creek might still be adjusting to changes caused by the 1906 quake.** Since there is no hard rock under-lying the stream bed, there is no bedrock control to impede this adjustment.

The principal limiting factor for salmon and steelhead in the Moat Creek basin, related to geology, is the lack competent bedrock and resulting lack of spawning substrate. The uplift rate has no direct bearing on presence or absence of salmonids since none could exist without spawning substrate.

Alternative Course Offered For Fisheries Restoration

There is no technically feasible or cost effective method to establish coho salmon or steelhead trout in Moat Creek. Because of the total lack of spawning substrate in the stream, gravels would have to be imported and weirs built in the stream to retain them. This exercise would be prohibitive in expense. The best restoration efforts are those where natural processes are restored so that benefits are self-sustaining. Any attempts to create fish habitat in Moat Creek would require constant maintenance and up keep. Even if spawning areas were established, other problems for productivity of fisheries might arise. Since most of the stream bottom is clay, invertebrate production might be restricted due to lack of surface area in the typical gravel matrix of a steelhead stream. Competition with other species would likely occur if salmonids were introduced, be harming the natural fauna of the stream.

Since it is not logical to expend funds on fisheries habitat improvements on Moat Creek, alternative proximate watersheds were examined as potential restoration sites. Pt. Arena Creek, to the north, and Ross Creek, to the south, both have similar bedrock geology to Moat Creek; therefore, neither stream would be a good alternative. Schooner Gulch, just to the south of Moat Creek, has hard rock underlying its watershed, the Iverson basalt formation. This igneous rock is well consolidated and was formed by volcanic activity at mid-Pacific spreading ridges then transported toward shore and uplifted by tectonic activity.

Schooner Gulch seems to be the best choice for expenditure of restoration funds because it is known to have steelhead runs at present and opportunities for fisheries and watershed restoration are present in the basin with some land owners willing to cooperate in such efforts. Approximately one half mile of Schooner Gulch, above Schooner Gulch State Park, was surveyed on November 5 to assess fish habitat conditions. The stream bed was predominantly a mixture of cobble, gravel and bedrock. This particle size distribution would be suitable for salmonid spawning and rearing, although some fine sediment was present. The canopy of the stream

was completely closed and some downed large trees added to habitat complexity. The average gradient of the stream was approximately 3% and riffles and runs were much more frequent than pool habitats. The North Fork of Schooner Gulch converged with the main stem in the reach surveyed and appeared to have elevated levels of fine sediment, which could be indicative of erosion problems in that sub-basin.

Schooner Gulch has a history of intensive timber harvest since World War II. Fisheries resources are thought to have declined substantially as a result of past flood damage after logging. More recent logging has been carried out in a more environmentally sensitive way but erosion risk may still be somewhat elevated. The logical progression for restoration in Schooner Gulch would be to implement erosion prevention measures to preclude stream damage in future floods and then to consider instream fisheries habitat improvement to increase pool frequency and depth. Another possible activity would be to restore the riparian canopy over Schooner Gulch if there are any areas where the stream lacks shade.

President Clinton's Forest Ecosystem Management Plan (FEMAT, 1993) recognizes the need to stem the loss of additional salmon and steelhead habitat by preventing erosion in future floods. Throughout the Pacific Northwest, $185 million will be spent to remove segments of roads that could trigger landslides and to remove or replace under-sized culverts that could lead to failure of stream crossings during floods. Similar activities are needed in Schooner Gulch to prevent damage to salmonid habitat in future large storms. The FEMAT (1993) report also projects expenditure of $215 million to restore riparian zones, Pacific Northwest wide, to help improve ecosystem function of cold water streams. The need for riparian improvements in Schooner Gulch are unknown at this time.

While steelhead have been seen spawning in Schooner Gulch in recent years, it is not known whether the stream is currently used by coho salmon. Coho salmon juveniles spend one year in freshwater and strongly prefer pools, especially those formed by large woody elements (Reeves et al., 1988). It is possible that past alterations in the stream channel, related to upland management and subsequent floods, may have decreased pool frequency and depth (NCRWQCB, 1993). Restoration activities in Schooner Gulch should consider the possibility of restoring coho salmon, if possible, because of the recognized risk of extinction of this species in the region (Higgins et al., 1992).

Conclusion

Moat Creek seems to have fully recovered from any detrimental impacts related to the bentonite spill in August, 1992 but it seems that the stream never harbored coho salmon or steelhead because of

natural geologic conditions. While it is infeasible to improve (or create) salmonid habitat in Moat Creek, the stream harbors a diverse and interesting population of amphibians which may make it of interest to local schools as field trip site for ecological studies.

Schooner Gulch has the natural geologic conditions that provide spawning substrate for salmonids. It currently supports steelhead and but implementation of erosion control and prevention would help to guard against habitat loss in future large storm events. Further studies are needed to determine if coho salmon are present or have occurred historically in Schooner Gulch. Restoration activities could involve improving pool frequency and depth to help recovery of this species.

Acknowledgements

Assistance of Rick Macedo and Ed Ramos of the Californian Department of Fish and Game in electroshocking surveys is gratefully acknowledged. Special thanks are also offered to Craig Bell who helped in the fisheries survey. Brian Thurmond, President of the Moat Creek Management Agency, showed special interest in this project, participating in all field surveys to better understand resource conditions in Moat Creek.

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Photo #1. Craig Bell shows Brian Thurmond some threespine stickleback he netted in the Moat Creek lagoon. Rick Macedo, of the California Department of Fish and Game, is shown operating the backpack electroshocker while Ed Ramos (also of CDFG) looks on.

Photo #2. The upper reach of Moat Creek has coarse bed materials and cool water but may be too small to accommodate steelhead spawning. Moss on stream side rocks indicates that the stream only fluctuates mildly during winter.

Photo #3. Pacific giant salamanders are abundant in upper Moat Creek. The two different sizes of larval salamanders shown probably represent different age classes.

Photo #4. Crews hired by AT&T help clean the lowest reach of the Moat Creek stream channel on the Hay Ranch in August 1992.

Photo #5. Geologist Danny Hagans examines signs of active down-cutting in the Moat Creek stream channel below Curly Lane. Note that the stream bed is clay at this point.

Photo#6. Danny Hagans shows Brian Thurmond how weak bedding planes in the sandstone bedrock of the Moat Creek watershed cause cobbles and gravels to break down as they are transported downstream.