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Riparian System Recovery after Removal of Livestock from Santa Rosa Island, Channel Islands National Park, California

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Introduction

In 1995, the California Central Coast Regional Water Quality Board, through a Cleanup and Abatement order, directed Channel Islands National Park to correct cattle grazing and road-related water quality problems on Santa Rosa Island. The order alleged that the park, by permitting improper road and riparian grazing management practices, was discharging unlawful concentrations of bacteria and sediment into waters of the state in violation of the regional water quality control plan for the Central Coast Basin.

As part of its effort to address the state's concerns, the park required a rapid evaluation of riparian-area conditions on Santa Rosa Island and an assessment of whether modifications to the existing livestock grazing management scheme could be used to meet water quality goals. An interdisciplinary team composed of personnel from the park, the National Park Service (NPS) Water Resources Division (WRD), the U.S. Forest Service, and the Bureau of Land Management (BLM) completed the field portion of that assessment during the week of March 20, 1995. The 1995 team's findings and recommendations for improved grazing management were published in a report titled *Federal Interagency Riparian Assessment and Recommendations for Achieving Water Quality Management Goals—Santa Rosa Island, Channel Islands National Park* (Rosenlieb et al. 1995).

Of the seven stream reaches that were subject to year-round cattle grazing, six were rated as "nonfunctional" and one was rated "functional–at risk." Of the three reference reaches, two were in "proper functioning condition" (PFC) and one was rated "functional–at risk." The authors concluded that Santa Rosa Island's degraded riparian areas had a very good chance of recovering if livestock management changed from year-round continuous grazing in most of the pastures to management that allowed for multi-year, or at least seasonal, rests from grazing. To that end, the report offered several alternative grazing strategies for consideration.

In 1998 the NPS, under a settlement agreement pursuant to a lawsuit regarding ungulate management on Santa Rosa Island, eliminated cattle from the island. Between 1998 and 2000, the NPS reduced the deer population by one-quarter and slightly reduced the elk population. Since these management changes, park employees have observed dramatic improvements in riparian vegetation cover and water quality. In 2004, the park requested technical

assistance from WRD to perform a post-grazing reassessment of Santa Rosa Island riparian areas. The idea was to apply the same techniques (PFC assessments and repeat photography) on the same stream reaches that were evaluated in 1995 to document vegetative and geomorphic changes in the six years since cattle were removed. Specifically, we wanted to see if riparian areas that were rated as "nonfunctional" or "functional–at risk" in 1995 had recovered to PFC simply by removing livestock, or if additional management steps are necessary to promote such recovery.

Methods

Based on a review of available methods for evaluating riparian functional condition, the 1995 team chose to apply the BLM's PFC method for the Santa Rosa Island riparian assessments. We decided that the most appropriate way to reassess riparian areas in 2004 was to have a comparable team of subject-matter experts (vegetation ecology, fluvial geomorphology, hydrology, riparian–wetland science) re-apply the same methods at the same sites and compare the results. Updated documentation for the PFC method can be found in *A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas* (BLM 1998).

The PFC technique uses an interdisciplinary team to assess the "functional condition" of riparian systems according to 17 hydrology, vegetation, and stream geomorphology factors. The "proper functioning condition" of a riparian area refers to the stability of the physical system, which in turn is dictated by the interaction of geology, soil, water, and vegetation. A properly functioning riparian area is in dynamic equilibrium with its streamflow forces and channel processes. The channel adjusts in slope and form to handle larger runoff events with limited perturbation of channel characteristics and associated riparian–wetland plant communities. Because of this stability, properly functioning riparian areas can maintain fish and wildlife habitat, water quality enhancement, and other important ecosystem functions even after larger storms. In contrast, nonfunctional systems subjected to the same storms might exhibit excessive erosion and sediment loading, loss of fish habitat, loss of associated wetland habitat, and so on.

Proper functioning condition does *not* refer to the seral stage or potential natural vegetation community of a riparian–wetland system. Rather, the evaluation is based on the concept that in order to manage for desired vegetation communities or habitat characteristics, the basic elements of a geomorphically stable system must first be in place and functioning properly. For example, riparian vegetation recovering from a recent fire may be in an early seral stage, and may even be missing an important component (e.g., woody vegetation was destroyed by the fire), but it may still be in proper functioning condition with respect to basic physical stability and the capacity to recover desired vegetation and habitat attributes over time.

Based on assessments of the 17 hydrologic, vegetative, and geomorphology elements of the riparian area, the interdisciplinary team assigns one of the following three functionality ratings to a site:

Proper functioning condition (PFC). Streams and associated riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:

- Dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality;
- Filter sediment, capture bedload, and aid floodplain development;
- Improve floodwater retention and groundwater recharge;
- Develop root masses that stabilize streambanks against cutting action;
- Develop diverse ponding and channel characteristics to provide habitat and the water depths, durations, temperature regimes, and substrates necessary for fish production, waterfowl breeding, and other uses; and
- Support greater biodiversity.

Functional–at risk. These riparian areas are in functional condition, but an existing soil, water, vegetation, or related attribute makes them susceptible to degradation. For example, a stream reach may exhibit attributes of a properly functioning riparian system, but it may be poised to suffer severe erosion during a large storm in the future due to likely migration of a headcut or increased runoff associated with recent urbanization in the watershed. When this rating is assigned to a stream reach, then its "trend" toward or away from PFC is assessed.

Nonfunctional. These are riparian areas that clearly are not providing adequate vegetation, landform, or large woody debris to dissipate stream energy associated with high flows, and thus are not reducing erosion, improving water quality, sustaining desirable channel and riparian habitat characteristics, and so on as described in the PFC definition. The absence of certain physical attributes such as a floodplain where one should exist is an indicator of nonfunctioning conditions.

The 2004 team further documented post-grazing riparian recovery by relocating 1995 photo points and taking new photos from the same locations. With the 1995 photos in hand, team members walked the assessment reaches and used visual clues to determine the locations and camera angles necessary to re-shoot the photos.

Results

Table 1 summarizes the results of the PFC analyses for the ten stream reaches surveyed in 1995 (year-round cattle grazing in most watersheds) and again in 2004 (six years after cattle were removed). The table shows that each of the six stream reaches that were rated "nonfunctional" in 1995 recovered to "proper functioning condition" after cattle were removed in 1998. The two Lobo Canyon reaches maintained their 1995 "proper functioning condition" ratings in 2004, although they showed remarkable improvements in the diversity, cover, and structure of native vegetation. Windmill Canyon (#1) and Acapulco Canyon (#7) are the only reaches that did not achieve "proper functioning condition" ratings in 2004. Both remain "functional–at risk." A full description of the 2004 survey findings is in a report published by the National Park Service (Wagner et al. 2004).

Of the stream reaches that recovered from "nonfunctional" to PFC, Arlington Canyon (Reach #5) had the most dramatic geomorphic and vegetative response (see repeat photography in Figure 1). The 1995 grazing-era photo shows a stream that is missing almost all of the components required for a properly functioning riparian system. An oversupply of sedi-

Stream reach (name and ID)	1995 PFC rating	2004 PFC rating
[1]Windmill Canyon (1)	functional–at risk (high)	functional–at risk (high)
[1]Lobo Canyon (2)	proper functioning condition	proper functioning condition
[1]Lobo Canyon (3)	proper functioning condition	proper functioning condition
Arlington Canyon (4)	nonfunctional	proper functioning condition
Arlington Canyon (5)	nonfunctional	proper functioning condition
Arlington Canyon (6)	nonfunctional	proper functioning condition
Acapulco Canyon (7)	functional–at risk	functional–at risk
Quemada Canyon (8)	nonfunctional	proper functioning condition
Old Ranch Canyon (9)	nonfunctional	proper functioning condition
Jolla Vieja Canyon (10)	nonfunctional	proper functioning condition

[1] *reference reach*

Table 1. Comparison of riparian condition assessment results from 1995 (year-round cattle grazing) and 2004 (six years after cattle were removed).

ment from upland and channel sources had exceeded the stream's transport capability, resulting in a mostly braided channel form, high lateral instability, high width-to-depth ratios, and other characteristics that were out of balance with the landscape setting. Riparian–wetland vegetation was absent, exposing banks to excessive erosion in each flood event. By 2004, this stream reach had recovered to a narrower, deeper, meandering channel with a well-developed floodplain and a gradient that is in balance with the landscape setting. Recovery of chaparral and riparian vegetation has apparently reduced excess runoff and erosion to the point where the stream is now in balance with the water and sediment being supplied by the watershed. Point bar development along the new meandering channel is one of the most striking geomorphic changes. For example, the large point bar at the center of the 2004 photo in Figure 1, which rises several feet above the current channel, did not exist in 1995.

Old Ranch Canyon (Reach #9) provides a second example of recovery from a "nonfunctional" condition during year-round grazing (1995) to PFC after removal of cattle and reductions in deer and elk populations (2004). The 1995 photo in Figure 2 shows the poor stream/riparian conditions that existed in 1995 (high width-to-depth ratios, unvegetated and eroding bars and channel banks, low sinuosity). By 2004, about 30% of this reach had developed narrower, meandering channel forms and well-vegetated channel banks and floodplains within the old incised channel. The rest of the reach recovered to a properly functioning system characterized by vegetated swales with nearly 100% cover within the older incised banks in most areas.

Figure 1. Arlington Canyon, 1995 (left) and 2004 (right). Recovery of vegetation, reduction of erosion, and point bar development between 1995 and 2004 resulted in a meandering stream channel in balance with the water and sediment being supplied by the watershed.

Figure 2. Old Ranch Canyon, 1995 (left) and 2004 (right). Cover and height of the native shrub coyote brush *(Baccharis pilularis)* increased considerably between 1995 and 2004.

Discussion and conclusions

The remarkable improvement in Santa Rosa Island's riparian conditions since 1995 demonstrates the ability of these systems to "self-restore" once the major stressor, year-round cattle grazing, was removed. The transitions from "nonfunctional" to PFC riparian systems became possible when vegetation recovery in the watersheds likely led to decreased runoff and sediment delivery to the island's stream systems and when appropriate bank-stabilizing and energy-dissipating vegetation became established in the riparian areas.

The PFC method proved to be a very useful tool for evaluating riparian system recovery on the island. However, we emphasize two points that are critical to a successful evaluation using this method: (1) the team must be carefully assembled to assure proper (and repeatable) application of the method, and (2) the team must understand that even though a riparian system may be in "proper functioning condition" with respect to geomorphic stability, it may not be on a trajectory toward a site's potential natural vegetation community or other desired vegetation condition.

Regarding the first point, the 1995 and 2004 PFC teams included subject-matter experts in all of the core assessment areas (vegetation ecology, fluvial geomorphology, hydrology, riparian–wetland science) who were also experienced in applying the PFC method. Although the PFC method is based on the BLM's well-established *quantitative* riparian assessment techniques (Leonard et al. 1992), team members must be able to draw on their experience with such methods to make rapid *qualitative* evaluations of the 17 checklist elements based on observations of field indicators. We were also careful to include local team members (Channel Islands National Park staff), who helped calibrate both teams' evaluations by clarifying land use history, identifying relic or "reference areas," providing local vegetation expertise, and so on. Three members of the 1995 team were included on the 2004 team, which helped promote consistency in application of the PFC method for the two assessments.

The second point is illustrated by the fact that even though stream reaches in Arlington, Quemada, Old Ranch, and Jolla Vieja Canyons recovered from "nonfunctional" in 1995 to PFC in 2004, the expected woody riparian components of these systems (willows and cottonwoods) have not become re-established. Therefore, in addition to reporting PFC functionality ratings, the team should also identify management actions that may be necessary to put functional systems on a trajectory toward desired future riparian–wetland vegetation conditions.

One reason for the absence of willows and cottonwoods on these reaches may be a lack of seed sources. Unlike many herbaceous wetland plants whose seeds can persist in soils for decades, cottonwood and willow seeds are very short-lived (1–2 weeks) and do not form seedbanks. Their wind-borne seeds are released in late spring, and in order to germinate and become established, they must fall on appropriate riparian substrates (bare, moist, mineral soils) during that short period of viability. The only remaining cottonwood stand on the island, found in Lobo Canyon, has not been observed to produce seed. These trees may be the result of vegetative reproduction from a single plant, either male or female. Many of the willows that remain on the island do produce seed, but they are mostly found in the uppermost reaches of the watersheds. Willow seed densities tend to drop off rapidly with distance from parent plants (Gage and Cooper 2003), so re-establishment may need to progress relatively slowly and incrementally down the canyons.

Herbivory by introduced deer and elk appears to be another important reason for the absence of willows and cottonwoods on most of the island's stream reaches. Though willow seedlings appear fairly often in some riparian areas, park staff report that these seedlings are consistently browsed away by ungulates in their first or second year. So, even if willow seeds do periodically find their way to appropriate riparian germination sites, we believe that deer and elk will continue to quickly and preferentially eat any seedlings that manage to get established.

Presence of willows, cottonwoods, and other woody riparian species may not be absolutely necessary in most of the drainages for channel bank and floodplain stabilization, but they would enhance such stability, help dissipate flood energy, trap sediment, and provide valuable wildlife habitat that would have likely occurred historically in the canyons.

Therefore, further reductions or elimination of introduced deer and elk and establishment of seed-bearing willows and cottonwoods at strategic locations may be necessary to promote a more complete recovery of riparian ecosystem structure and function on Santa Rosa Island.

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