THE IMPLICATIONS OF RECENT FLOODPLAIN EVOLUTION ON HABITAT WITHIN THE MIDDLE RIO GRANDE, NEW MEXICO

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Abstract: Understanding the recent history (past 50 years) and current trends of river processes within the Middle Rio Grande (MRG) is important information for managing and restoring the current and future conditions of the MRG's fluvial-riparian habitat. During the past 50 years, flood control efforts have greatly reduced, and in many places eliminated, the connection between peak flows and floodplain surfaces. Pre flood-control processes include erosive banks, erosion of floodplain surfaces, and creation of floodplain surfaces. Disruption of these processes has affected the riparian community as well as the structure of native fish habitat.

Important physical factors determining the MRG's ability to maintain processes that create floodplain habitat include incision/aggradation rates, bankline mobility, sediment supply and the hydrograph. In order to assess the relative importance of these factors, a site-based physical habitat characterization of the MRG has been placed into sections defined by incision/aggradation rates. The MRG is divided into three of these sections, separated by transition zones, including: Section 1 (Sediment Supply Influenced Section) extends from Cochiti, NM to about Los Lunas, NM (~70 river miles), Section 2 (Uplift Influenced Section) extends from Arroyo Abo to Escondida, NM (~47 river miles), and Section 3 (Aggrading Section) constitutes the last 30 river miles is aggrading (Massong et al., 2006). Bankline complexity, bankline position and velocity distribution within the channel are used as surrogates for physical habitat characterization (Tashjian and Remshardt, 2005) in this study.

The majority of the historic floodplain within Section 1 is disconnected from the MRG at flows below 5000 cfs. Though often referred to as the "floodplain", this surface functions as a terrace and has been abandoned by river incision through flood and sediment control measures. Even when overbanking occurs, the flows do not contain the energy to disrupt the flooded surface. From Bernalillo, NM to Bernardo, NM (~75 river mile), jetty jack lines were placed in the mid 20^{th} century to stabilize bank locations. These structures, coupled with ensuing non-native vegetation, have 'frozen' the banklines creating a ~600 foot wide active channel corridor within the ~1800 foot wide "floodway". Within this corridor, active river processes are limited by upstream sediment supply and the hydrograph. The most vital modern habitat occurs in two parts of this Section; 1) south of Bernalillo in the transition from a multi to a single threaded channel, 2) from Isleta Diversion south where a floodplain-like surface has recently developed within the 600 foot wide corridor.

The most important shift for habitat within Section 2 is the cessation of the jetty jack defined river corridor and the input of sediment and high flows from unregulated tributaries. Where uplift of the Socorro Magma Body has produced a long history of river incision, the modern River has continued to create floodplain surfaces through bank erosion and bar growth associated with the occasional high discharge events. The result is complex in-channel fish habitat, and a

fairly complex age and class structure to the riparian community. The active river corridor for this Section is bound by uplifted terraces and ranges between 450 and 1200 feet.

Sections 3 contains some of the best habitat within the MRG, barring intermittence. Within these Sections, the MRG alternates between a wide, active channel and a narrow, channelized river with frozen banks. Connected floodplain surfaces within the wider sections include both in-channel bar and island surfaces and true floodplain surfaces, creating an active river corridor that ranges between 1200 and 6000 feet.

This assessment suggests that habitat quality within the Middle Rio Grande is primarily dependent upon sediment supply, the variability of the hydrograph and bank mobility. The physical processes associated with channel incision/aggradation are interrelated to, though not solely explained by these processes. In Section 1, where incision is associated with a reduction in sediment caused by reservoir operations, habitat quality is, in general, poor. The degradation associated with the incision in Section 1 is compounded by immobile banks and an altered hydrograph. In Section 2 where incision is associated with the uplift of the Socorro Magma body, sediment supply is sufficient, banks are more mobile, and the hydrograph is more variable in both low flow and peak flow variability than found in Section 1: the result is better habitat.

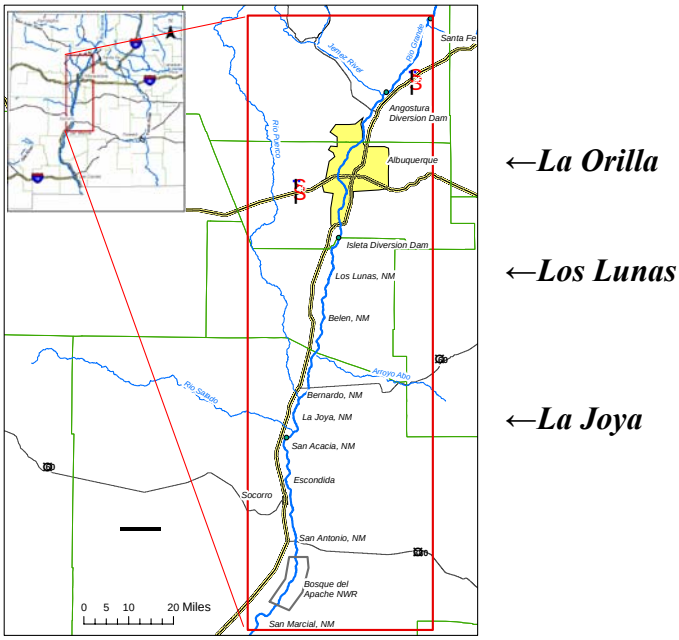

Figure 1 Location of the Middle Rio Grande within the State of New Mexico with locations of habitat sites.

INTRODUCTION

The Middle Rio Grande (MRG) of New Mexico encompasses roughly 170 river miles from the Cochiti Reservoir to the headwaters of Elephant Butte Reservoir and sits at a juncture between fairly intact mainstem Rio Grande ecosystems to the north and primarily denuded ecosystems to the south (Figure 1). There has been a considerable amount of focus on the physical-ecological functioning of the Middle Rio Grande over the past decade (Crawford et al., 1993: Robert,

2005). Recent work by Massong et al. (2006) describes recent incision patterns within the Middle Rio Grande. This paper discusses how habitat quality differs within the incision segments and relates any differences to the primary physical functions of sediment supply, hydrographic diversity and bankline stability.

DATA AND METHODS

Massong et al. (2006) utilize a variety of data to assess the degree of channel incision throughout the MRG which includes: terrace maps in the high incision areas, field observations of bank heights to assess degree of incision especially where terrace maps do not currently exist, review of historical and current bed elevation data, aerial photography to better define active floodplains, and GIS base layer/map. The incision based delineation of the MRG derived from the above analysis is used as a basis for weighing the importance of key physical processes for habitat quality within this paper.

The original and complete habitat data are found in Remshardt and Tashjian (2005), which describes habitat quality within the MRG in a variety of geomorphic provinces. Field collected data for habitat quality for this study included: 1) shoreline position and complexity as a function of discharge, 2) in-channel physical characteristics including velocity distribution, depth distribution, sediment distribution, and flow angle distribution, 3) cross sectional response to flow regime. Each site is roughly 0.75 miles length and contains 4 evenly spaced transects where physical characteristics are measured every 4 feet. Although 10 sites were surveyed in the original study, data from only three sites are presented here.

Remshardt and Tashjian (2005) describe habitat quality within the Middle Rio Grande using the above data, however, for this discussion we discuss bankline position and velocity distribution since these parameters can be easily compared and addressed. Shoreline position and complexity are meaningful habitat surrogates for the MRG since they demonstrate shoreline accessibility as a function of flow and complexity of the bank-floodplain interface. A reach that contains a mobile bankline and a complex bank-floodplain interface is considered better habitat as it represents areas where there is greater channel-floodplain connectivity. Greater amounts of active floodplain surfaces benefit both the native riparian species and native fish species (Remshardt et al., 2003; Crawford et al., 1993). In-channel velocity profiles are meaningful habitat surrogates for the MRG since they demonstrate the complexity of fish habitat. A reach that contains greater diversity of velocities within the channel at varying flow levels is considered better habitat since it satisfies the habitat requirements of native fish species and associated life stages (Remshardt et al., 2003). These data have been compared with the incision descriptions from Massong et al. (2006) to form a broader understanding of habitat.

RESULTS

The three sites selected for discussion in this paper are La Orilla, La Joya and Los Lunas (Figure 1). Each of these sites represents different habitat reaches of the Middle Rio Grande, as defined by Remshardt and Tashjian (2005), and have different incision character as defined by Massong et al. (2006).

The La Orilla Site which has a moderate-high incision character (Reach 3 from Massong et al., 2006) is located near Albuquerque, NM in the Albuquerque Valley Habitat Reach (Remshardt and Tashjian, 2005). This Site is typified by banks that are frozen in place by jetty jack lines (Figure 2), and a relatively tall abandoned floodplain. The site receives only a moderate amount of sediment supply and has a limited hydrograph. During the calendar years of 2000 through 2004, daily mean flows were between 100cfs and 1000cfs 95% of the days. Due to the frozen bank positions in this reach and an abandoned floodplain, flows in this range supply the in-channel habitat with very homogeneous velocity habitat availabilities (Figure 5). This site is considered poor habitat (Remshardt and Tashjian, 2005).

The La Joya Site is in the Sevilleta Habitat Reach of the MRG (Remshardt and Tashjian, 2005), has a high amount of incision (Reach 8 from Massong et al., 2006), however this site has good habitat. This Site is typified by bankline positions that vary with increasing flow (Figure 3) and associated floodplain surfaces at moderate (200cfs-500cfs) flow levels. Due to tributary input, this site has a larger sediment supply than the La Orilla Site and a hydrograph that is more diverse in the low, mid, and high flow ranges. The velocity profiles for the site are diverse at all flow ranges (Figure 6).

The Los Lunas Site is in the Isleta Habitat Reach of the MRG (Remshardt and Tashjian, 2005), has almost no incision (Massong et al., 2006), and contains good habitat. This Site is similar to the La Orilla Site in that it has banks that are frozen in place by jetty jack lines and a moderate amount of sediment supplied from upstream reaches (Figure 4). However, unlike the La Orilla Site, the hydrograph contains greater diversity at low to moderate flows which has caused the formation of bar and island floodplain surfaces that flood at moderate (200cfs to 500cfs) and high (>1000cfs) flow ranges. These in-channel floodplain surfaces contribute to diverse velocity profiles at all flow levels (Figure 7). Where the hydrographic diversity at this site assists in improved habitat, it is often at the cost of intermittency which is very damaging to native fish populations and riparian habitat (Remshardt et al., 2003; Crawford et al., 1993).

DISCUSSION

Based on the data at all ten sites, the most important factor in classifying the quality of habitat appears to be the existence of active floodplain processes regardless of incision. An example of this distinction is a comparison between the La Orilla and the La Joya Sites. Although both sites contain high banks due to incision, the La Orilla Site has very little to no subsequence floodplain development while the La Joya Site has a variety of flow dependant floodplain surfaces. The incision at the La Orilla Site is attributed primarily to the reduced sediment supply in the Rio Grande due to sediment capture in Cochiti Reservoir upstream of the Site. This sediment depredation is compounded by frozen banklines and a homogeneous hydrograph resulting in poor habitat. The incision at the La Joya Site, however, is caused by a more natural process of localized uplift created by a magma body located immediately downstream from the Site (Socorro Magma Body). Coupled with this process are mobile banklines and a diverse hydrograph resulting in quality habitat.

The Los Lunas Site provides an interesting insight into how the altered physical processes in the Albuquerque Reach (as represented by the La Orilla Site) could be adjusted to improve habitat.

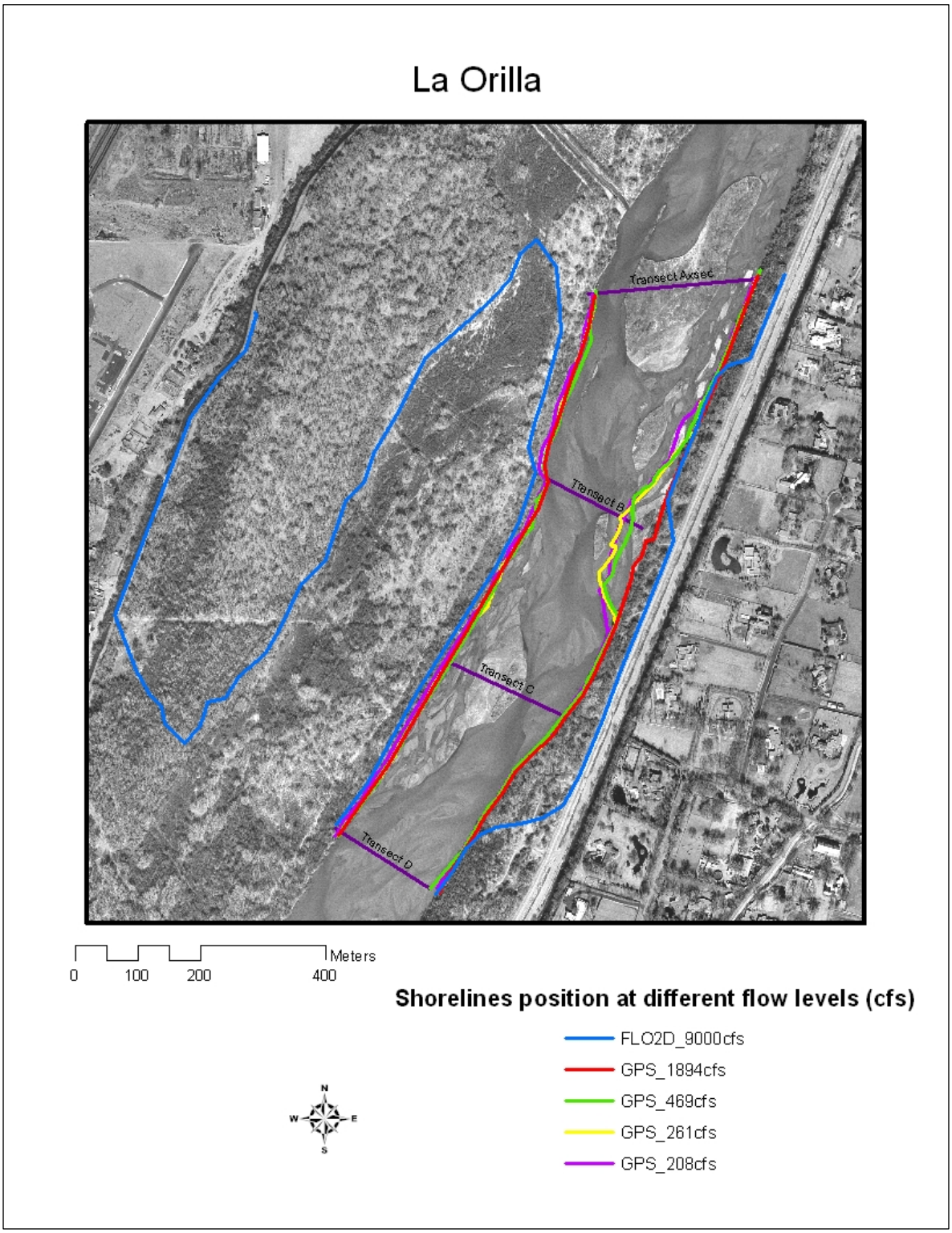

Figure 2: Shoreline position at various flow levels for the La Orilla Site. This site is considered to be have moderate to high incision, banks armored by jetty jack lines, moderate sediment supply with a relatively low diversity in the annual hydrograph. For flows above 2000cfs, the FLO2D model was used to estimate bankline position (Tetra Tech, 2004).

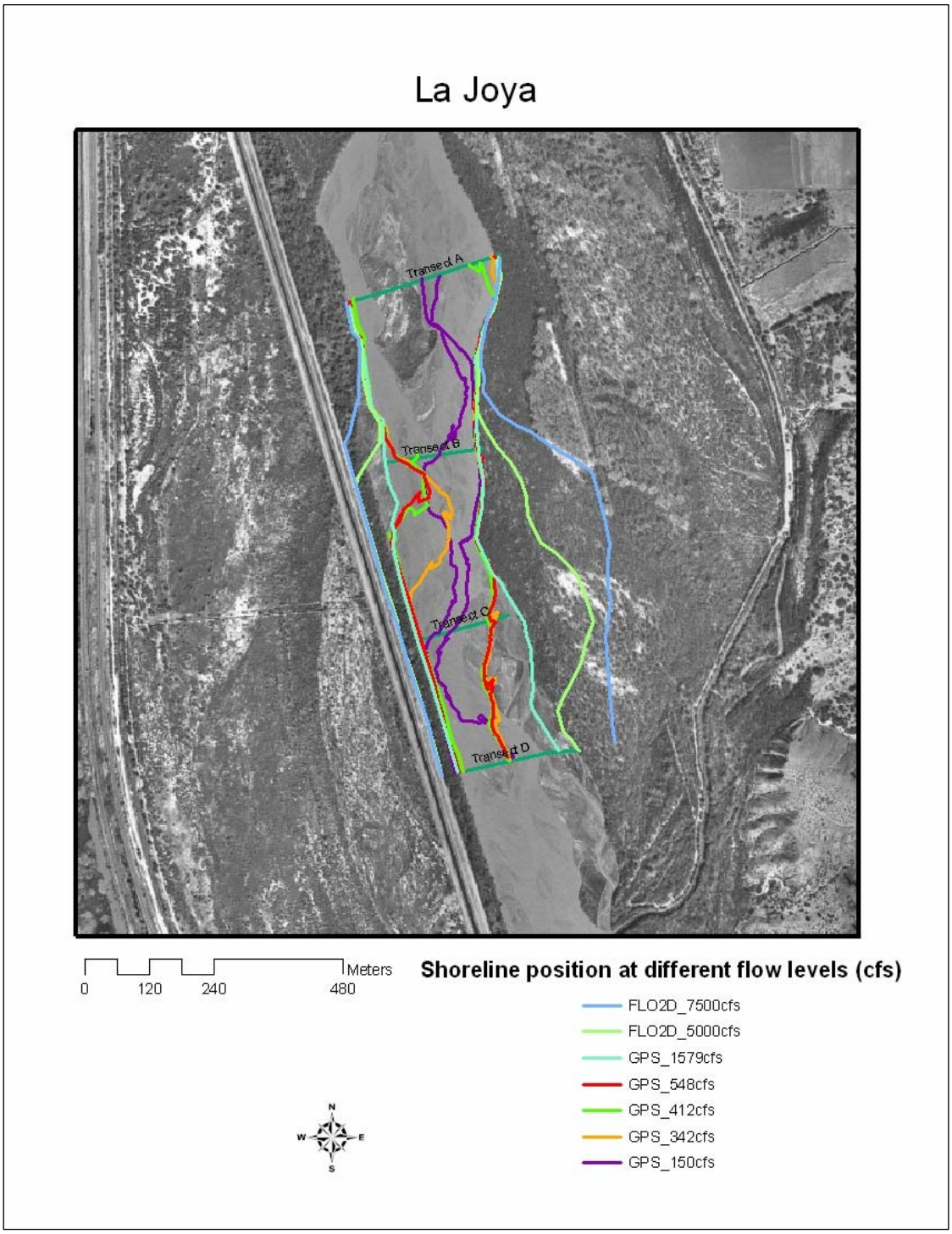

Figure 3: Shoreline position at various flow levels for the La Joya Site. This site is considered to be highly incised with a combination of banks that are both free and armored by jetty jack lines and a high sediment supply. This site also has a hydrograph that is diverse in low, mid and high flow ranges. For flows above 2000cfs, the FLO2D model was used to estimate bankline position (Tetra Tech, 2004).

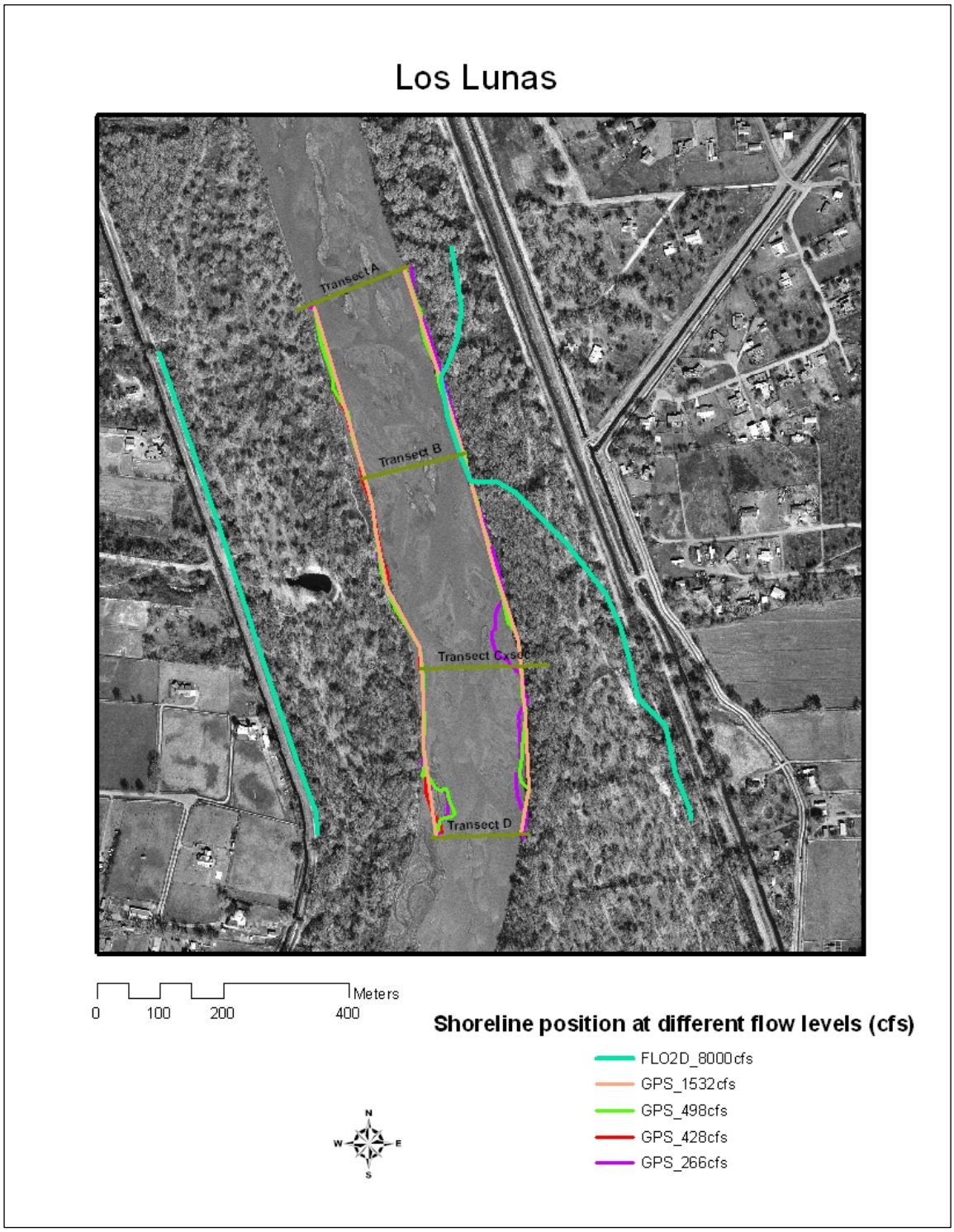

Figure 4: Shoreline position at various flow levels for the Los Lunas Site. This site is considered to be an area of no recent incision. The banks are armored by jetty jack lines and there is a moderate sediment supply. This site has a hydrograph that is diverse in low, mid and high flow ranges. For flows above 2000cfs, the FLO2D model was used to estimate bankline position (Tetra Tech, 2004).

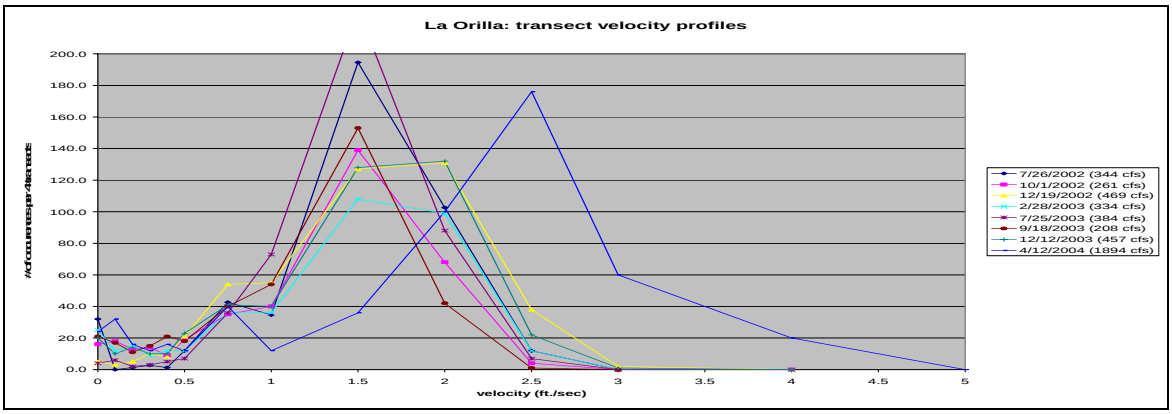

Figure 5: Velocity profiles for the La Orilla Site at various flow levels. These types of profiles are associated with poor habitat since there are very little in-channel velocity diversity at all flow levels.

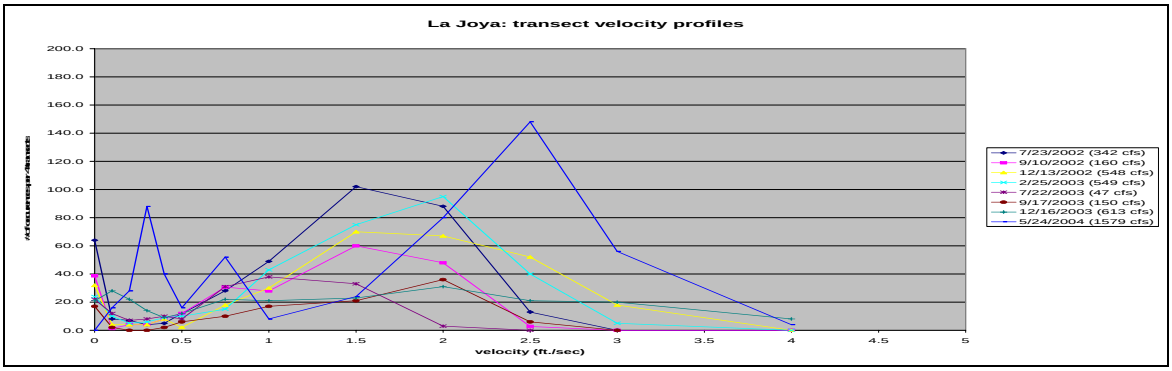

Figure 6: Velocity profiles for the La Joya Site at various flow levels. These types of profiles are associated with good habitat since there are diverse in-channel velocity diversity at all flow levels.

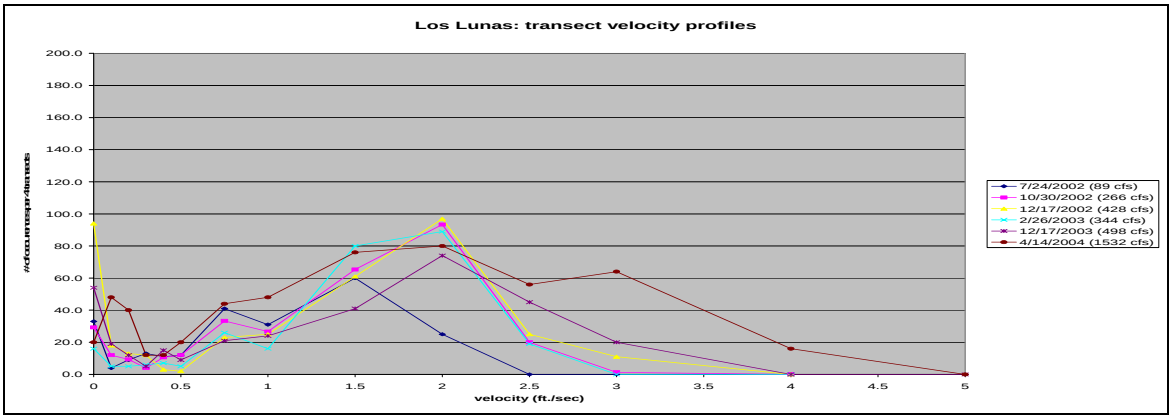

Figure 7: Velocity profiles for the Los Lunas Site at various flow levels. These types of profiles are associated with good habitat since there are diverse in-channel velocity diversity at all flow levels.

The primary difference between the La Orilla and Los Lunas Sites is that there is greater hydrographic diversity in the low and mid flow ranges at the Los Lunas Site. This diversity in the hydrograph, barring intermittence, has led to complex in channel habitats and modern bar and island floodplain surfaces, components of quality habitat.

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