City of Austin
WATERSHED PROTECTION

**Identifying source populations of freshwater mussels in the lower Colorado River**

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## Abstract

Urbanization and resulting changes in hydrology and sediment composition are the primary factors limiting mussel abundance and diversity in Austin, TX. These changes have resulted in a shift to more tolerant, generalist freshwater mussel taxa while increasing the threat of local extirpation. In order to make conservation and restoration recommendations the viability of source populations for colonization in the Lower Colorado River was investigated. The city of Austin sampled 28.8 stream kilometers of the Colorado River below Longhorn Dam in summer of 2011 to locate extant mussel beds and quantify if adequate recruitment is occurring for recolonization of nearby tributaries. No live mussels and relatively few recently dead individuals were collected from our sampling zones. The presence of preferred substrate and host fish populations was identified. These results suggest that temperature and flow disruptions are likely hindering mussel recruitment on the Lower Colorado River. Without viable source populations, successful conservation of remaining mussel populations are at increased risk from current regulated flow disturbance regime.

## Introduction

A continental extinction crisis is currently underway for North American freshwater mussels. Of the nearly 300 native species, 213 taxa (72%) are considered endangered, threatened, or of special concern (Williams *et al.* 1993). There is growing evidence that urbanization impacts to hydrology is leading to this decline (Gangloff and Siefferman 2009, Stranko *et al.* 2010, Duncan 2011). Downstream of three highly urbanized tributaries in Alabama with degraded habitat and water quality, mussel abundance was substantially reduced (Gangloff and Siefferman 2009). Populations of rare mussels in Maryland were found to only inhabit streams with low impervious cover and urbanization influences (Stranko *et al.* 2010). Preliminary studies performed by the City of Austin have linked presence of live mussels with low amounts of impervious cover (Duncan 2011). Live mussels or spent valves were located in watersheds containing an average of 6.9% impervious cover (N=15) compared to 30.6% (N=13) for those watersheds where none

were found (Duncan 2011). These findings support other published results linking limited mussel diversity to hydraulic stress at both low and high flow events (Strayer 1999, Newton *et al.* 2008, Randklev *et al*. 2009, Allen and Vaughn 2010). High percentage of impervious cover within a watershed is commonly attributed to altered hydrology in streams, leading to more frequent higher flow events coupled with prolonged periods of low flow and droughts (Walsh *et al.* 2005). As sessile organisms freshwater mussels are unable to migrate in response to hydrologic disturbances. Maintaining connectivity between mussel patches ensures that a given population can resist isolated disturbance events through recolonization from nearby patches. Without source populations available for recolonization a mussel species may become extirpated from a system following a disturbance event. Understanding the dynamics of potential source populations is necessary prior to implementing restoration and conservation strategies in City of Austin waterways.

Mussel surveys can be either qualitative or quantitative, and both can employ a variety of methods for determining if a mussel species is present within a given water-body. Burlakova *et al*. (2011) recently established that the number of species found in timed (qualitative) searches was significantly higher than quadrate (quantitative) methods. However, quantitative surveys are important for understanding temporal changes in mussel densities, age structure, and habitat features during before-and-after surveys (WDNR 2005). Both rapid and timed qualitative surveys can be employed to determine presence of rare and common species through multiple habitat types while covering a large geographical range (WDNR 2005). We utilized a double sampling approach, primarily using timed surveys, on the lower Colorado River in order to assess the viability of freshwater mussels in this reach that should be the source population for other catchments in the region.

## Methods

*Study Area*

The nearly 30 km stretch of the Colorado River from Longhorn Dam to Little Webberville Park was divided into two zones and sampled for mussels using a double sampling for stratification approach (Strayer and Smith 2003). The upper sampling zone extends from the Highway 183 crossing down to Farm to Market 973 (Figure 1). The downstream zone began at Little Colony Park and extended down to Little Webberville Park (Figure 1).

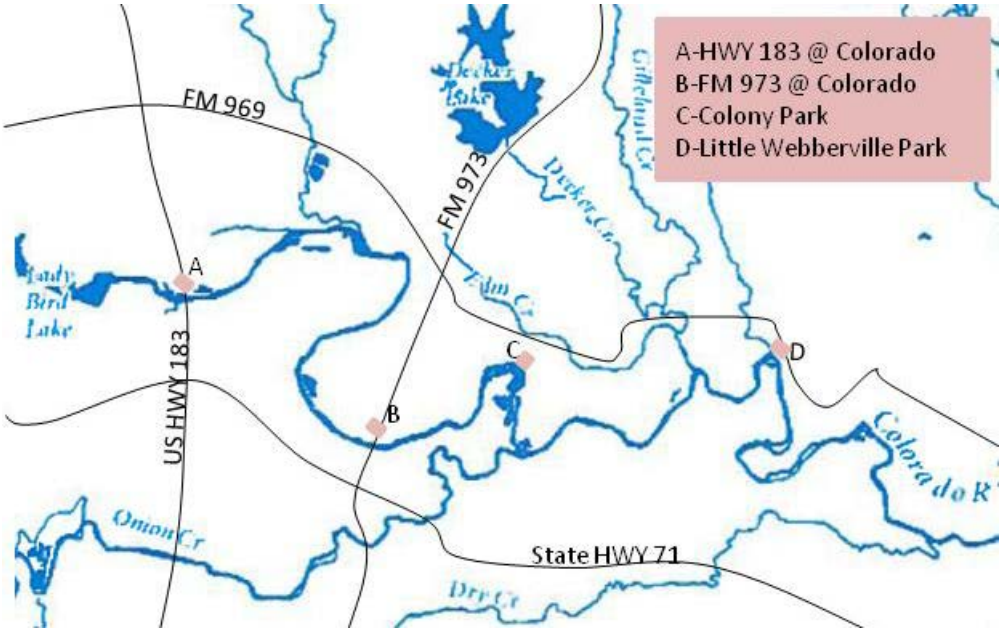

**Figure 1**: Colorado River from Lady Bird Lake Past little Webberville Park.

*Survey Methods*

Mussels were located using a combination of visual and snorkeling methods. Wadable areas (< 1 meter) of the stream were visually surveyed while deeper areas (1- 3 meters) were surveyed with mask and snorkel combined with free diving. All live and recently dead (containing tissue remains and/or internal and external colors not faded) were identified in the field, photographed, and measured with calipers to the nearest mm. Live individuals 3 years old or less were denoted separately for each mussel species found.

*Assessing Viability*

The number of live individuals less than three years old is used as an indication of recent recruitment of a mussel species (WDNR 2005). A population is considered viable if they have shown evidence of sustained recruitment (represented by un-even age class distribution). Coefficient of variation (CV):

$$c_v = \frac{\sigma}{|\mu|}.$$

CV can be calculated for each mussel species to quantify differences within and among populations. A higher CV corresponds to an improved diversity of age classes and indicates successful recruitment. However, if mussel beds are not located and there is no evidence of live specimens present (recently dead valves), then it can be concluded that source populations are void from the sampled reach.

*Statistical Analysis*

Relative density as catch/unit of effort (number of mussels per zone found live and recently dead / hours total search effort for each zone) and Shannon-Wiener diversity index were calculated for each sampling zone (Upper and Lower). ANOVA was used to quantify significant spatial differences in density and diversity among sampled zones. Regression analysis was used to look

for trends in mussel diversity compared to distance from longhorn Dam. Frequency distributions of ages were calculated for all sampled species

*Hypotheses*
1. There are no mussel beds (>5 individuals/ $m^2$) on the Colorado River.
2. There is no mussel recruitment occurring on the Colorado River.
3. Mussel diversity increases with distance from Longhorn Dam on the Colorado River.

## Results

A total of 28.8 stream kilometers was sampled downstream of Longhorn Dam to Little Webberville park consisting of 26.45 survey hours. All geomorphic units and habitat types (riffles, pools, runs, islands, point bars, sloughs, and upstream end of lateral scour pools) were sampled for both the upper and lower zone. Dominant substrate type consisted of a sand/gravel mix with some cobble riffles and exposed bedrock. In stream vegetation was dominated by Water stargrass with small patches of Hydrilla and Eurasian water milfoil. Discharge was higher during the upstream (ave. 2,100 cf/s) vs. downstream (ave. 1,000 cf/s) sampling events.

No live mussels and few relatively recently dead mussels were located (Table 1). There is no substantial evidence to indicate the presence of live mussel beds (> 5 individuals/ $m^3$) on the Colorado River from HWY 183 to Little Webberville Park. Several long dead and sub-fossil specimens were collected but were not pertinent to this investigation. Although few total recently dead freshwater mussels were collected it appears that diversity and abundance was increasing downstream of Longhorn Dam. Anecdotally, the abundance of host fish populations (Bass, sunfish, catfish, alligator gar, minnows, shiner, and darters) also appeared to increase with downstream distance. Live *corbicula* were present throughout the entire sampling reach in both the upper and lower sampling zones.

**Table 1**: Number of recently dead freshwater mussel shells collected on the Colorado River in the Upper Zone (HWY 183 to FM 973) vs. the Lower Zone (Colony Park to Little Webberville Park).

| Species | Upper Zone | Lower Zone |
|---|---|---|
| Pondhorn | 1 | 2 |
| Southern Maple Leaf | 0 | 2 |
| Giant Floater | 0 | 2 |
| Yellow Sandshell | 0 | 1.5 |

## Discussion

*Temperature and flow disruptions*
Although adult mussels can likely withstand some of the sediment scouring resulting from the elevated discharge coming from Lake Travis; the necessary recruitment and juvenile attachment could be impacted. Morales *et al.* (2006) has found that increasing flow velocities may prevent the necessary recruitment of juvenile mussels and hinder the long-term survival of otherwise

healthy mussel beds. Without adequate recruitment healthy mussel beds will disappear as adult mussels' die-off due to old age. Mussel reproduction and vertical movement can be triggered by temperature cues (Schwalb *et al.* 2007 and Galbraith and Vaughn 2009). Water temperatures in impounded systems are significantly colder and exhibit less seasonal variability. Without these seasonal shifts, and/or with out-of-season temperature cues, the production of gametophytes in adult mussels can be impacted and overall successful reproduction may be inhibited below impoundments (Galbraith and Vaughn 2009).

*Physical impoundments*
Due to their host fish requirements freshwater mussel distribution is greatly impacted by stream impoundments. Mussel extinction gradients have been observed directly downstream of an impoundment where species richness and abundance was lowest nearest the impoundment and increasing with distance (Vaughn and Taylor 1999). Considerable stream lengths are required to overcome the impoundment effects with rare species occurring at sites furthest downstream (Vaughn and Taylor 1999). Although not quantified; the abundance of host fish appeared to increase with downstream distance from Longhorn Dam. This could be explained by the elevated discharge during the upstream sampling effort or lack of available habitat. Additional quantifiable studies need to be performed in order to test the association of host fish and mussel abundance in the lower Colorado.

*Sediment Stability*
Freshwater mussels inhabit a variety of water-body types with wide ranging substrate compositions. More commonly substrate stability, not composition, has been linked to higher density and diversity of mussels (Strayer 1999, Randklev et al. 2009, Allen and Vaughn 2010). Limiting substrate types consist of deep shifting sand, deep silt, and most boulder and cobble habitat (Howells et al. 1996). The most populated areas contain mud, sand, gravel, and cobble or a combination of these (Howells et al. 1996). Preferred substrate is available throughout the lower Colorado; however, elevated flows resulting in frequent substrate instability likely decrease the availability of preferred substrate as habitat for mussels.

## Recommendations

Future sampling efforts should focus on mussel populations in Lady Bird Lake. This reservoir contains the most diverse assemblage of freshwater mussels in Austin. Live specimens of the Threeridge, Southern Mapleleaf, and Pistolgrip have only been discovered by COA staff in Lady Bird Lake. Evaluating the health of the remaining populations in the reservoir is necessary before a conservation status can be established. Protecting the remaining freshwater mussel populations should be a priority for maintaining biodiversity and water quality of the reservoir.

Additional Surveys in our larger watersheds (Onion, Dry, Gilleland, and Wilbarger) and protected ponds and oxbows of the Colorado are warranted to rule out the presence of rare and cryptic species. Locating existence of potentially federally listed species (Texas Fatmucket, Smooth Pimpleback, Golden Orb, Etc...) in Austin is necessary prior to establishing a conservation plan.

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