Attachment K

Effects of changing height of Cape's Dam on Texas wild rice and fountain darter habitat in the San Marcos River, Texas

Prepared for:

U. S. Fish and Wildlife Service

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INTRODUCTION

The River Systems Institute (RSI) at Texas State University was asked by the U.S. Fish and Wildlife Service San Marcos National Fish Hatchery and Technology Center to assist in the evaluation of the implications if Cape's Dam was either at half its existing height or was removed on habitats for the endangered Texas wild rice (TWR) and fountain darters in the San Marcos River. RSI was provided with existing data collected by the previous contractor and in conjunction with existing data, supplemental field data, and habitat models developed at RSI, we undertook hydrodynamic and habitat modeling under these two theoretical conditions as well as existing conditions. Habitat modeling followed the same procedures utilized to assess Texas wild rice and fountain darter habitat as employed in the development of the Edwards Aquifer Recovery Implementation Program for consistency.

METHODS

Study Areas

Figure 1 shows the spatial extent of the assessment conducted in the San Marcos River. The study area includes the reach from Rio Vista Dam downstream to the TPWD State Hatchery outflow.

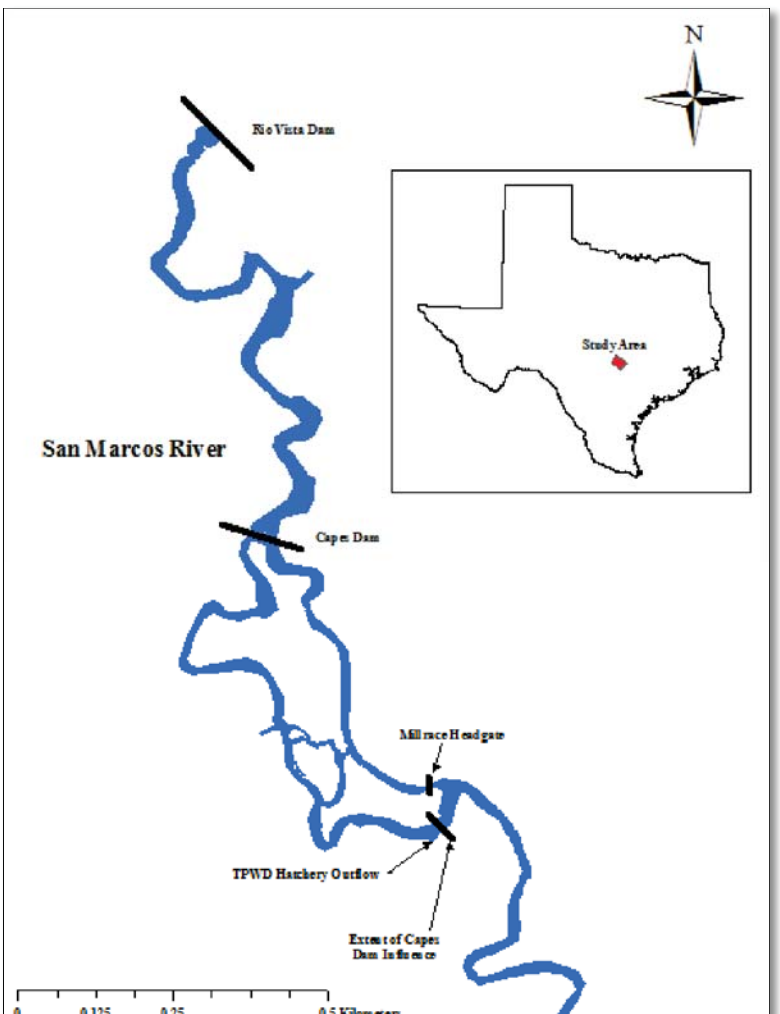

Figure 1. San Marcos River study area.

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All highlighted section was Copied & Pasted into Hardy's Oct 2015 report (see Attachment I, pg 5, first paragraph.)

Field Data Collection for Channel Topography and Substrate

Topography (i.e., elevation), substrate, vegetation, and surface water elevation data were collected from September 2009 – April 2010. Standard survey equipment and GPS Trimble XH units were used to measure topography within the wetted portion of the stream using a systematic irregular sampling strategy that targets capturing all available heterogeneity within the stream. Latitude (x), longitude (y), depth, and substrate type were recorded in Trimble dictionaries for each point surveyed. Vegetation within the stream was delineated with polygons with corresponding percentages of each vegetation or substrate type recorded for each polygon. Vegetation polygons were spatially joined with the hydrodynamic modeling grids to assign roughness values and vegetation class attributes for habitat modeling of darters and Texas wild rice. Discharge and water surface elevation (WSE) longitudinal profiles were recorded each day during field measurements of channel topography.

Topographic Data Reduction, Computational Mesh Generation, Hydraulic Modeling and Calibration

Adaptive Hydraulics (ADH) is an unstructured finite element package capable of modeling 2-dimensional and 3-dimensional shallow water equations, 3-dimensional Navier Stokes equations, groundwater equations and groundwater-surface water interaction. ADH solves the hydraulic and transport equations while dynamically adapting the mesh so that a coarse mesh can give results as accurate as a mesh with finer resolution. (Berger et al., 2011). ADH contains other essential features such as wetting and drying, completely coupled cohesive and non-cohesive sediment transport. A series of modularized libraries make it possible for ADH to include vessel movement and friction descriptions. The User's Manual for Adaptive Hydraulics Modeling system provides additional information on the hydrodynamic modeling capabilities of ADH (Berger et al., 2011).

Initial water surface elevations under existing conditions were obtained from the calibrated two-dimensional hydrodynamic models developed at Texas State University (Hardy et al., 2010). Additional topography field observations collected by Texas State University were used to supplement existing topography data in Hardy et al. (2010) during mesh construction. Additional information of sediment type and distribution were also provided by Dr. Paul Hudson (University of Texas – Austin) and supplemented with field observations by RSI. RSI data were added to the substrate and vegetation polygon data from Hardy et al. (2010) to update model roughness spatially within the model. The ADH model included 15 different substrates including areas that consisted of 100 percent silts, sands, cobbles, and gravels, and also mixtures of materials such as sands and gravels, gravel cobble, etc. The model also included, as a separate roughness region, areas of very dense vegetation. Roughness values "Manning's n" varied from .026 to .075, the highest value used, .075, is for areas of dense vegetation (Table 1).

Table 1. Roughness (height in meters) of vegetation and substrate within the San Marcos River, Texas.

Substrate Type	Roughness (m)
Bedrock	0.027
Boulder/Cobble	0.050
Clay	0.030
Cobble	0.050
Concrete	0.050
Gravel	0.050
Gravel/Cobble	0.050
Gravel/Sand	0.040
Gravel/Sand/Silt	0.040
Large Boulder	0.050
Metal	0.050
Sand	0.030
Silt	0.030
Silt/Sand	0.030
Small Boulder	0.050
Vegetation	0.075

Four different steady flows were modeled for this the study; these flows, ranging from 45 to 300 cfs, are shown in Table 2.

Table 2. Modeled discharge and percent of time exceeded for the San Marcos River.

Discharge cfs	Discharge cms	Percentage of time flow equaled or exceed * (1995-2011)
45	1.27	Not Determined
100	2.83	90
173	4.9	50
300	8.5	10

* Flows Measured at USGS Gage 08170500 San Marcos River at San Marcos, Texas

Hydraulic model calibrations followed standard engineering practice by changing model parameters such as roughness and viscosity until agreement between predicted and observed water surface elevation profiles were achieved under existing dam conditions. For the half-height dam scenario, the dam height was simply reduced to half its current elevation. For the no-dam scenario, the dam was effectively removed to approximate the bed elevation above and below the dam based on measured elevation data. Dam height elevations used in this modeling effort are shown in Table 3. Mapping of the raw data to a defined computational mesh was accomplished using triangular irregular networks to derive a mesh of approximately 16.37 m^2 resolution. This process is illustrated graphically in Figure 2.

Table 3. Cape's Dam elevation (m) at full dam height, half dam height, and full dam removal on the right and left side.

	Full Dam Height	Half Dam Height	No Dam
Cape's Dam Right Side	167.9 m 550.8 ft	167.38 549.1 ft	166.87 547.5 ft
Cape's Dam Left Side	168.22 m 551.9 ft	167.53 549.6 ft	166.84 547.4 ft

3.3 ft - height of R

4.5 ft - height of L
3.9 ft - Average height of Cape'sDam

Table 3 is the same data used for Cape's Dam in the Jun 23, 2014 report presented in Trondheim, Norway, (see Attachment P, Page 4, Table 2) which produced different results than presented in this report, Attachment K, from 2012.

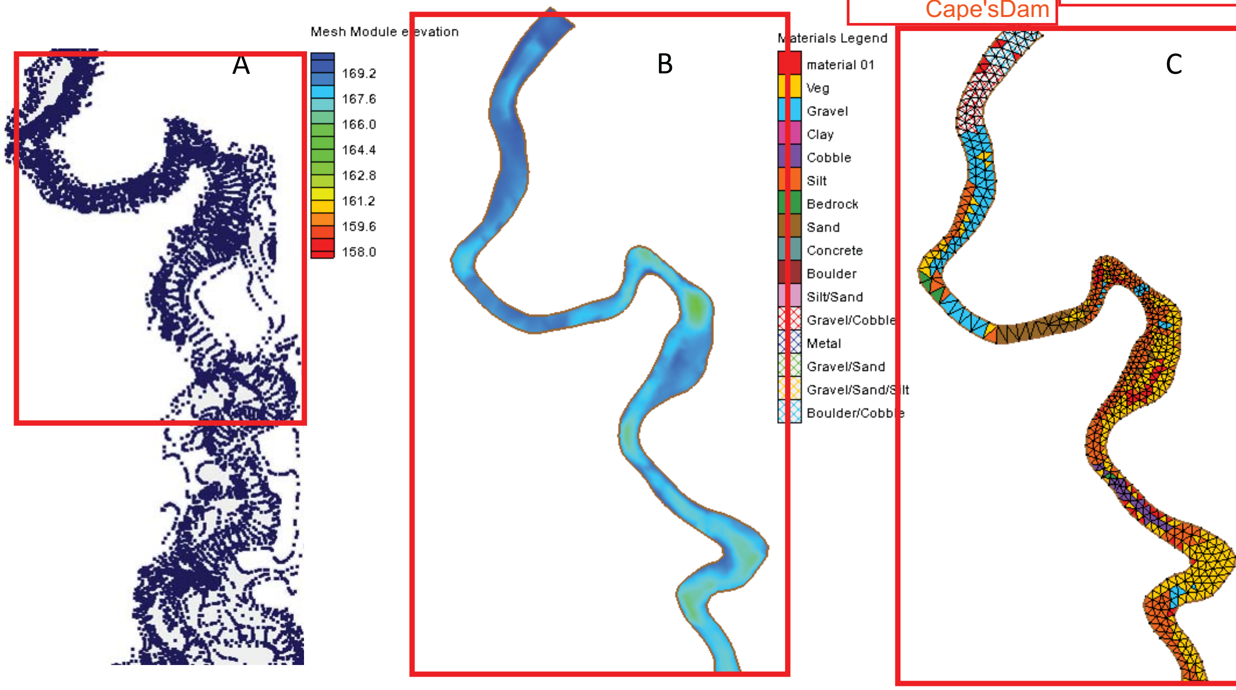

Figure 2. Example of field measured topography points (A) and computational mesh mapped onto elevation contours (B) and substrate (C).

Habitat Suitability Criteria (HSC)

HSC for depth and velocity for TWR adapted from Saunders et al. (2001) was used in modeling physical habitat quantity and quality assessments as described below. In addition, HSC for depth, velocity, and vegetation/substrate for darters were also adapted from Saunders et al. (2001) and data provided by BIOWEST, Inc., from field monitoring in the San Marcos River between 2001 and 2009 (BioWest 2010a, b).

Figure 3 provides the depth and velocity HSC for TWR. Figure 4 provides the HSC for depth and velocity for darters whereas Table 4 provides the HSC values for substrate/vegetation. The darter HSC for depth was modified to extend no limitation on depths given empirical observations while diving has shown darter utilization in the deepest parts of Spring Lake on San Marcos River. Previous curves showed declining suitability at higher depths reflective of gear bias (Thom Hardy, personal observation).

These 3 depictions of Figure 2 do not cover the same aerial extent and are thus invalid comparisons. See 2016-06-24 Report by Thom Hardy's private company Watershed Systems Group which repeats this same incorrectly constructed Figure - a repetition of which Hardy was paid $10,000 and possibly more.

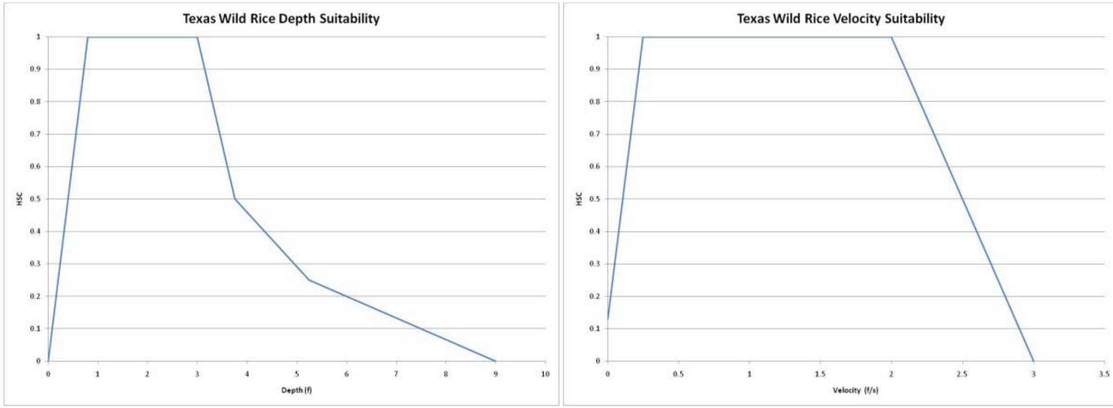

Figure 3. Depth and velocity Habitat Suitability Curves for Texas wild rice.

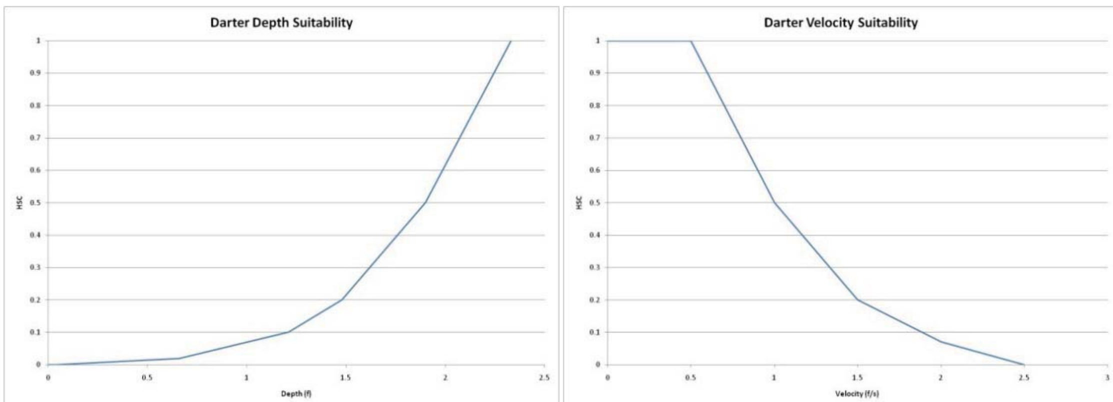

Figure 4. Depth and velocity Habitat Suitability Curves for fountain darters.

Table 4. Habitat Suitability Index values for substrate and vegetation codes for the fountain darter.

Substrate Type	HSI value
Bedrock	0.05
Boulder/Cobble	0.05
Clay	0.05
Cobble	0.10
Concrete	0.05
Gravel	0.05
Gravel/Cobble	0.08
Gravel/Sand	0.05
Gravel/Sand/Silt	0.05
Large Boulder	0.05
Metal	0.05
Sand	0.05
Silt	0.05
Silt/Sand	0.05
Small Boulder	0.05
Vegetation	0.70

Where is the raw data for the SMS solution files? How was this data generated/collected? This are "simulation results" - not a guarantee that this is what will happen.

Physical Habitat Quantity and Quality

Texas Wild Rice

Simulation results from the SMS solution files were exported into Microsoft Excel and a Visual Basic for Applications utility was used to generate Texas wild rice component habitat suitability index (HSI) values for depth and velocity at each computational cell based on the component HSC values for depth and current velocity. Component HSI values ranged from 0.0 to 1.0, with a value of 0.0 indicating no suitability whereas a 1.0 indicates 'optimal' conditions.

Texas wild rice HSC for depth and current velocity suitability were used to generate predicted Texas wild rice weighted useable area (WUA) for each modeled discharge. The combined suitability for Texas wild rice was derived as the geometric mean of the component suitabilities for depth and current velocity as follows:

$$\text{TWR Combined Suitability} = (\text{TWRdS} * \text{TWRcvS})^{1/2}$$

TWRdS is the depth suitability and TWRcvS is the current velocity suitability. The relationship between the amount of Texas wild rice WUA at existing dam height, half dam height, and full dam removal of Cape's Dam was calculated for each modeled discharge. WUA was expressed as the percent of the total surface area for each discharge. Plan view plots of the combined suitability predicted for TWR for each scenario at each flow rate were also generated.

Fountain Darters

Simulation results from the SMS solution files were exported into Microsoft Excel and a Visual Basic for Applications utility was used to generate darter component HSI values for depth and velocity at each computational cell based on the component HSC values for depth and current velocity. Component HSI values ranged from 0.0 to 1.0, with a value of 0.0 indicating no suitability whereas a 1.0 indicates 'optimal' conditions.

Fountain darter HSC for depth and current velocity and substrate/vegetation suitability were used to generate predicted fountain darter WUA for each modeled discharge. The combined suitability for fountain darters was derived as the geometric mean of the component suitability's for depth, velocity and substrate/vegetation as follows:

$$\text{Combined Suitability} = (\text{FDdS} * \text{FDcvS} * \text{FDsubS})^{1/3}$$

Where FDdS is the depth suitability, FDcvS is the current velocity suitability, and FDsubS is the substrate/vegetation type suitability. Basically, given the hydraulic attributes of depth and velocity at a given node location and the associated vegetation/substrate code, the component suitability for each factor is computed and the resulting geometric mean is multiplied by the area of the cell to yield WUA. The WUA for a given discharge is simply the sum of all non-zero WUA for all computational cells at that discharge. The relationship between the amount of fountain darter (WUA) at existing dam height, half dam height, and full dam removal of Cape's Dam was calculated for each modeled discharge. WUA was expressed as the percent of the total surface area for each discharge. Plan view plots of the combined suitability predicted for fountain darter for each scenario at each flow rate were also generated.

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RESULTS

San Marcos Physical Habitat Modeling

A total of 18,874 topography points collected within the study area (September 2009 – January 2010) and from Hays County, Texas, contour maps to extend elevation outside the river's edge were used. Predicted wetted stream area as a function of simulated discharge for the San Marcos River is provided in Table 5 for each Cape's Dam scenario. Total wetted stream area ranged from 42,742 m^2 at 45 cfs (no dam) to 48,758 m^2 at 300 cfs (half dam height).

Table 5. Predicted wetted area (m^2) at various discharges for three Capes's Dam scenarios including full dam height, half dam height, and no dam within the study area of the San Marcos River.

Discharge (cfs)	Full Dam Height		Half Dam Height		No Dam	
45	43,175.32	10.67 ac	42,936.49	10.61	42,742.07	10.56 acres
100	46,354.70	11.45	46,218.02	11.42	46,130.61	11.40
173	47,240.00	11.67	47,177.26	11.66	47,140.28	11.65
300	48,722.48	12.03	48,758.06	12.05	48,724.64	12.04

How do you have an increase in wetted area, without a dam, at 300 cfs?

All other flow rates below 300 cfs show a decrease in wetted area.

Simulated Physical Habitat

Table 6 and Table 7 (respectively) provide the range and mean of modeled available depths and current velocities at discharges of 45, 100, 173, and 300 cfs for three Cape's Dam scenarios, full dam height, half dam height and no dam within the study area of the San Marcos River. Appendix A provides a visualization of available depths and current velocities for 45, 100, 173, and 300 cfs for each Cape's Dam scenario.

Table 6. Range (mean) of modeled depths (m) within the study area of the San Marcos River at various discharges for three Cape's Dam scenarios including full dam height, half dam height, and no dam.

Discharge (cfs)	Full Dam Height	(ft)	Half Dam Height	(ft)	No Dam	(ft)
45	0 - 4.31 (0.94)	(3.08)	0 - 3.92 (0.90)	(2.95)	0 - 3.80 (0.86)	(2.82)
100	0 - 4.48 (1.15)	(3.77)	0 - 4.11 (1.10)	(3.61)	0 - 4.03 (1.08)	(3.54)
173	0 - 4.64 (1.36)	(4.46)	0 - 4.34 (1.30)	(4.27)	0 - 4.28 (1.30)	(4.27)
300	0 - 4.83 (1.63)	(5.35)	0 - 4.60 (1.60)	(5.25)	0 - 4.55 (1.60)	(5.25)

Table 7. Range (mean) of modeled current velocities (m/s) within the study area of the San Marcos River at various discharges for three Cape's Dam scenarios including full dam height, half dam height, and no dam.

Discharge (cfs)	Full Dam Height	(f/s)	Half Dam Height	(f/s)	No Dam	(f/s)
45	0 - 0.21 (0.06)	(0.20)	0 - 0.21 (0.06)	(0.20)	0 - 0.22 (0.07)	(0.23)
100	0 - 0.27 (0.11)	(0.36)	0 - 0.29 (0.12)	(0.40)	0 - 0.30 (0.12)	(0.39)
173	0 - 0.37 (0.16)	(0.52)	0 - 0.39 (0.20)	(0.66)	0 - 0.40 (0.20)	(0.66)
300	0 - 0.59 (0.24)	(0.79)	0 - 0.50 (0.24)	(0.79)	0 - 0.51 (0.24)	(0.79)

Velocity slows from a range of 0-.59 to 0-.51 *without* a dam?

Compare this report, dated Jan 17, 2012 (Attachment K, page 8) with Hardy's report dated June 23, 2014 (Attachment P, page 5)

In both reports Hardy utilizes the same dam height scenarios (full, half, none) and same water volumes (45, 100, 175, and 300cfs) yet derives different Depths and Velocities.

Compare this page (Attachment K, page 8) Table 6 - to Attachment P, page 5, Table 3 for **Depth**
Compare this page (Attachment K, page 8) Table 7 - to Attachment P, page 5, Table 4 for **Velocity**

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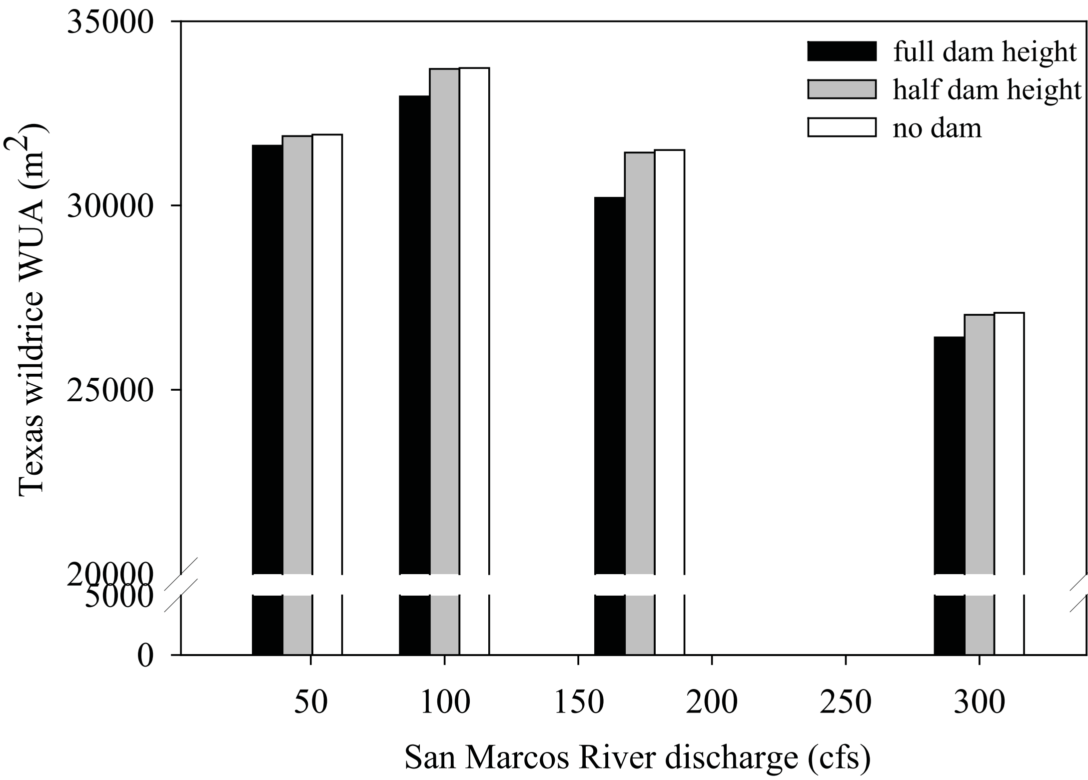
Simulated TWR WUA

The results for simulated TWR WUA at a discharge of 45, 100, 173, and 300 cfs for each dam scenario are provided in Table 8 and illustrated in Figure 5. Total predicted TWR WUA ranged from 26,419 m^2 at 300 cfs (full dam) to 33,729 m^2 at 100 cfs (no dam). Overall, the simulated removal of Cape's Dam increased the amount of suitable TWR habitat. Figure 6 provides a comparison of the combined suitability based on depth and velocity HSC for TWR at 173 cfs for the three Cape's Dam scenarios (0 low suitability – 1 high suitability). Plan view plots of the combined suitability predicted for TWR for each dam scenario at each modeled flow rate are provided in Appendix B.

Table 8. Predicted Texas wild rice Weighted Useable Area (m^2) within the study area of the San Marcos River at various discharges at full dam height, half dam height, and no dam scenarios for Cape's Dam.

Discharge (cfs)	Full Dam Height	Half Dam Height	No Dam
45	31,620.33 7.81 ac	31,884.65 7.88	31,919.93 7.89 acres
100	32,957.93 8.14	33,703.76 8.33	33,729.88 8.33
173	30,209.55 7.46	31,437.69 7.77	31,505.39 7.79
300	26,419.99 6.53	27,031.42 6.68	27,087.37 6.69



In this report (2012) the graphs for Texas Wildrice **include a flow rate of 300 CFS**.

In 2015, in the 2 reports written for the City of San Marcos, dated June 24, 2015 and Oct 10, 2015 - Texas Wildrice **omitted a flow rate of 300 CFS**, even though the contract between Hardy and the City of San Marcos specifically calls for 300 CFS flow rate to be included in the studies.

Figure 5. Predicted Texas wild rice Weighted Useable Area (m2) within the study area of the San Marcos River at discharges of 45, 100, 173, and 300 cfs for three Cape's Dam scenarios including full dam height (black bars), half dam height (gray bars), and no dam (white bars).

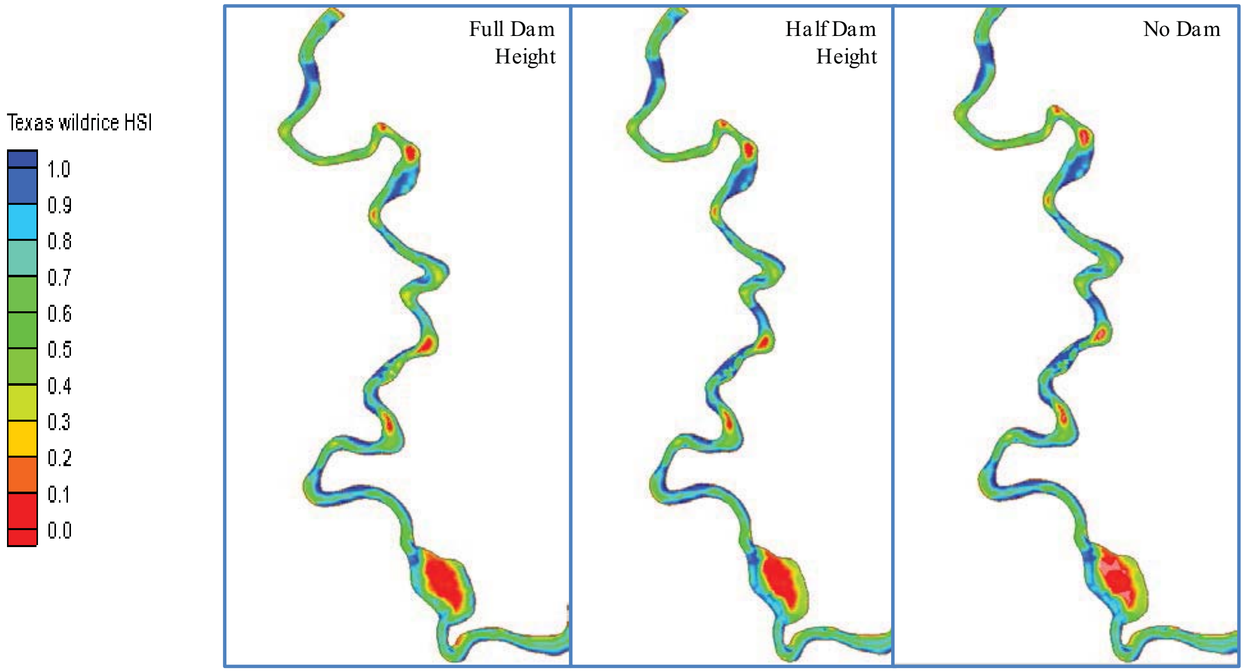


Figure 6. Combined suitability for Texas wild rice physical habitat at 173 cfs for Cape's Dam scenarios including full dam height, half dam height, and no dam within the study area of the San Marcos River.

The percent of TWR WUA as a function of stream surface area within the study area of the San Marcos River decreased with increasing discharge. The scenario of completely removing Cape's Dam predicted the highest percent use of stream area for TWR WUA among all discharge rates (74.68% at 45cs – 55.59% at 300cfs) whereas Cape's full dam height scenario predicted the lowest (73.24% at 45cfs – 54.22% at 300 cfs) (Figure 7).

At 300 cfs there is only a 1.3% improved WUA if Capes Dam is removed. Note that in Hardy's Oct 2015 report (Attachment I, pg 18) states "The total reduction in stream area with half height and full Removal is 15 and 17 percent (%), and are primarily a result of reduced or elimination of flows in the Mill Race." **It is unusual that a loss of habitat of 15-17% produce a 1.3% gain in Texas Wild Rice.**

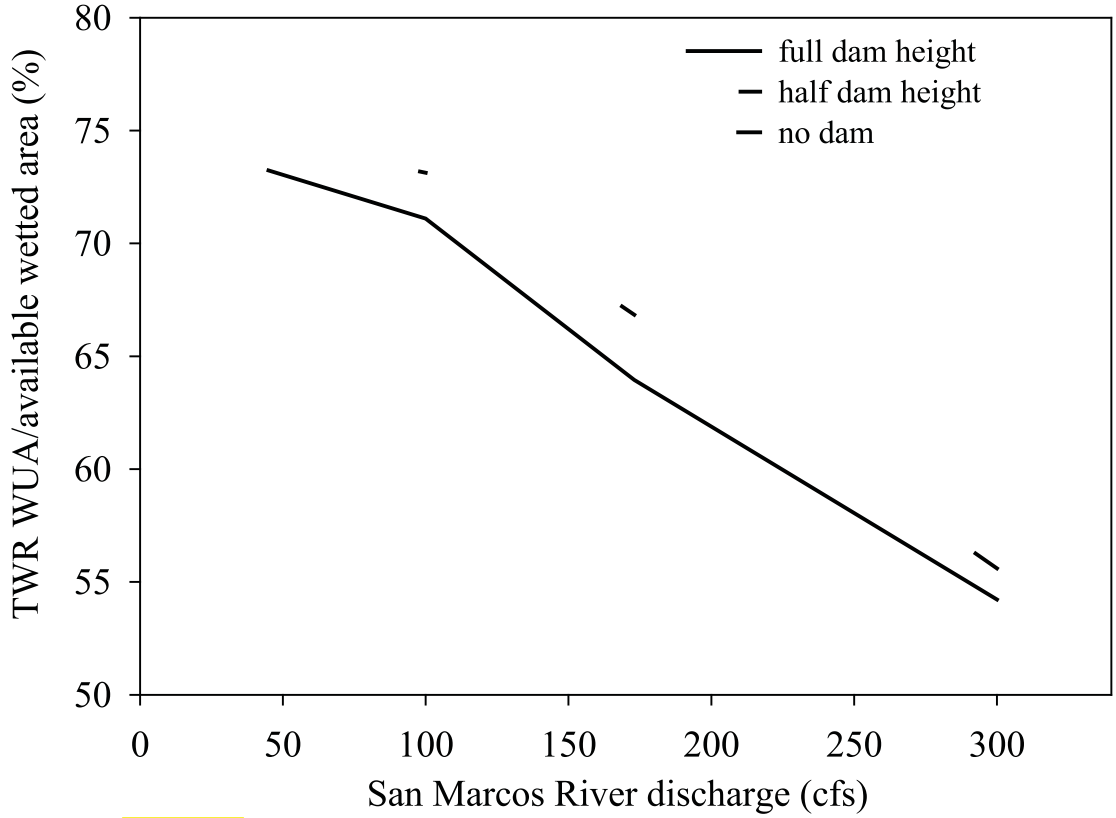


Figure 7 shows a predicted available Texas wild rice WUA - how were these figures derived/ generated/ predicted?

Figure 7. Predicted available Texas wild rice Weighted Useable Area/available wetted area (%) within the study area of the San Marcos River at discharges of 45, 100, 173, and 300 cfs for three Cape's dam scenarios including full dam height (solid line), half dam height (dash dot dot line), and no dam (dashed line).

Fountain Darters

Simulated Fountain Darter Physical Habitat

Totals for predicted fountain darter WUA are provided in Table 9 and illustrated in Figure 8. Fountain darter WUA in the study area ranged from 16,745 m^2 at 45 cfs (no dam) to 22,389 m^2 at 173 cfs (full dam height). Figures 9 provides an example of the combined suitability of darter habitat at 173 cfs at each Cape's dam scenario. Plan view plots of the combined suitability for fountain darters at each simulated discharge for each Cape's Dam scenario are provided in Appendix B.

Table 9. Predicted fountain darter Weighted Useable Area (m^2) within the study area of the San Marcos River at various discharges at full dam height, half dam height, and no dam scenarios for Cape's Dam.

Discharge (cfs)	Full Dam Height	Half Dam Height	No Dam
45	18,290.69	17,592.73	16,745.51
100	21,536.20	21,045.48	20,650.97
173	22,388.94	21,931.64	21,898.85
300	21,809.15	21,592.53	21,738.65

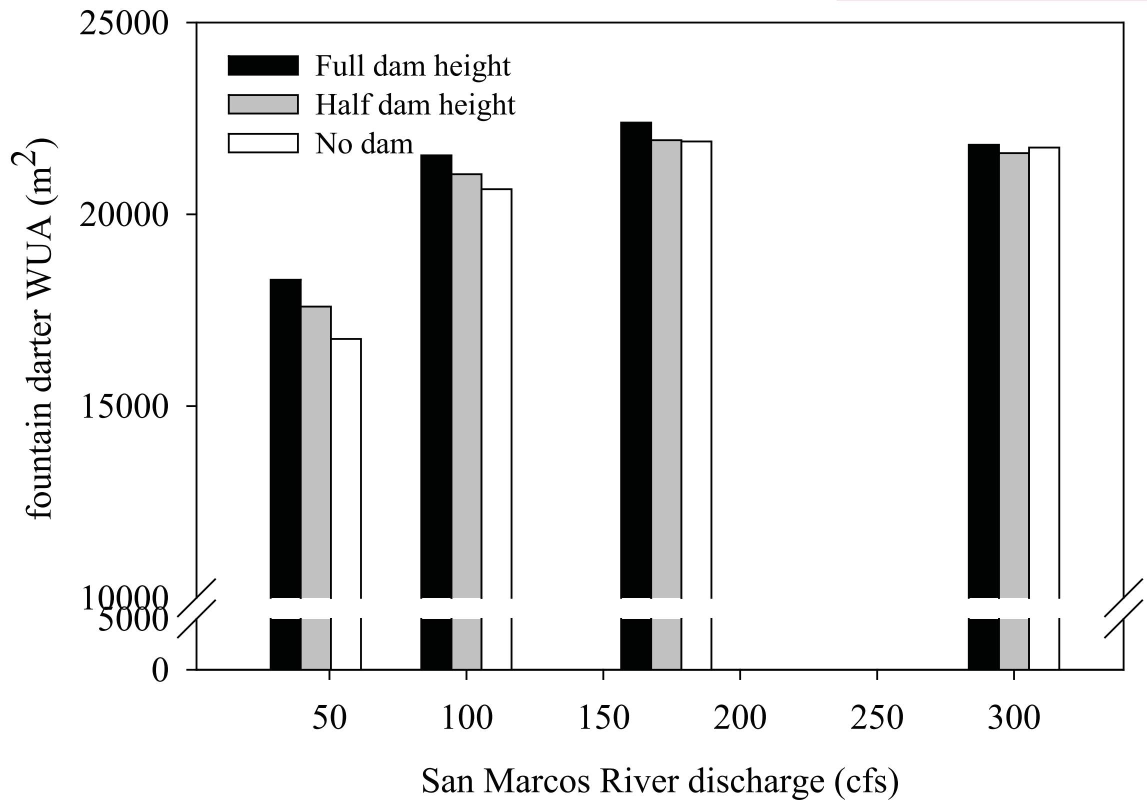


Figure 8. Predicted fountain darter Weighted Useable Area (m2) within the study area of the San Marcos River at discharges of 45, 100, 173, and 300 cfs for three Cape's dam scenarios including full dam height (black bars), half dam height (gray bars), and no dam (white bars).

Under this prediction, Full Dam height shows the best net positive WUA, at all flow rates. This prediction of Jan 17, 2012 indicates the best scenario for the Fountain Darter is to re-build Capes Dam immediately, in order to ensure the endangered Fountain Darter habitat is not lost through further dam erosion, such as has occurred in Oct 2013, May 2015, October 2015, and most recently as Sept 26, 2016 - all since this reports states the BEST scenario for the Fountain Darter is Full Dam Height.

Due to the erosion of the 4 major floods that have occurred since this report, Capes Dam has been greatly damaged and eroded from what in 2012 would have been considered "Full Height".

Two breaches of Capes Dam have been created since the Oct 2013 floods; both were widened and deepened considerably in the Sept 26, 2016 flood consisting of 7 inches of rain in 6 hours, creating approximately 2200cfs of flood water flow. The effect of the Mill Race no longer being supplied with water are immediate and clear cut: stagnant water is rapidly becoming a mosquito breeding ground and supply through the Mill Race to Thompson's Gin is a fraction of what is was before the flood, but at same flow rates (200-300cfs.)

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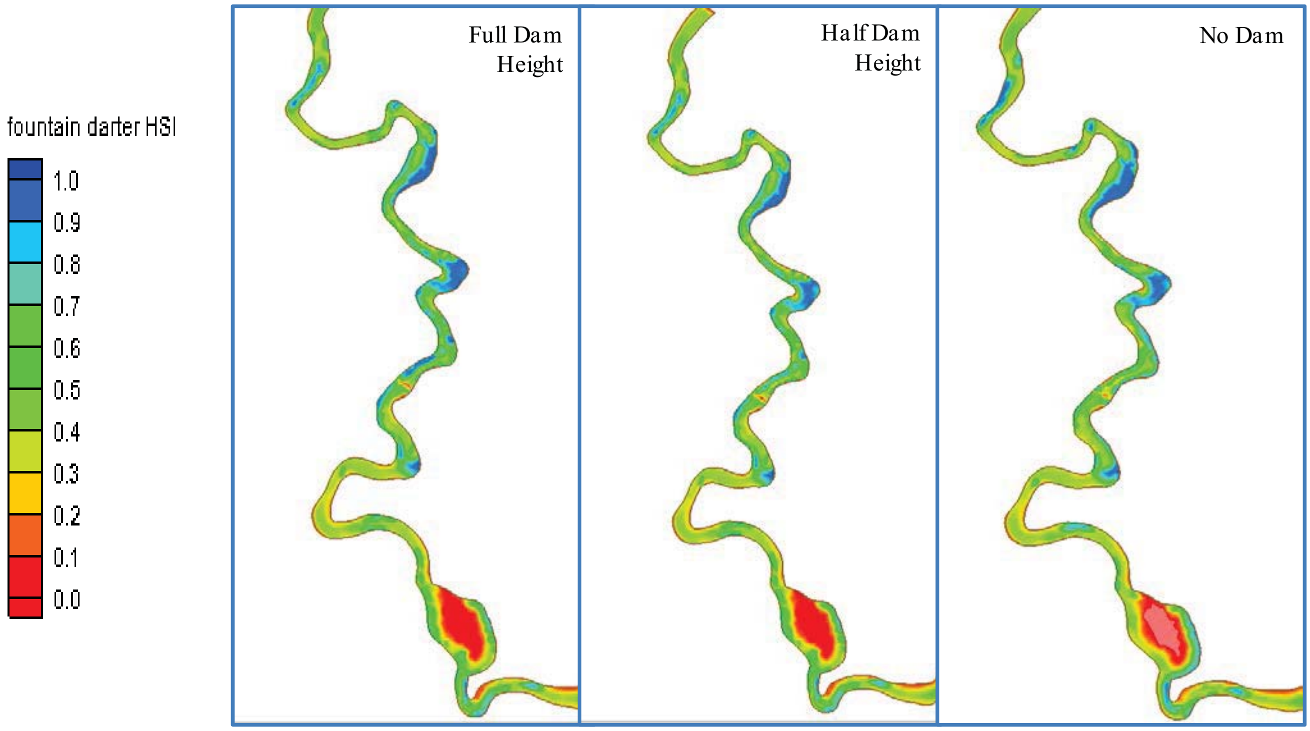

Figure 9. Combined suitability for fountain darter habitat at 173 cfs for Capes Dam scenarios including full dam height, half dam height, and no dam within the study area of the San Marcos River.

Fountain WUA as a percent of total stream area increased between 45 cfs and 173 cfs but decreased at 300 cfs for all three Cape's dam scenarios (Figure 10). Maintaining Cape's dam at full height predicted a higher percent of available habitat as suitable fountain darter habitat, but only slightly (47.4% at full dam height versus 46.5% at no dam at 173 cfs).

See previous page's comments for a the same conclusion that this report makes: **<u>This prediction of Jan 17, 2012 indicates the best scenario for the Fountain Darter is to re-build Capes Dam immediately</u>.**

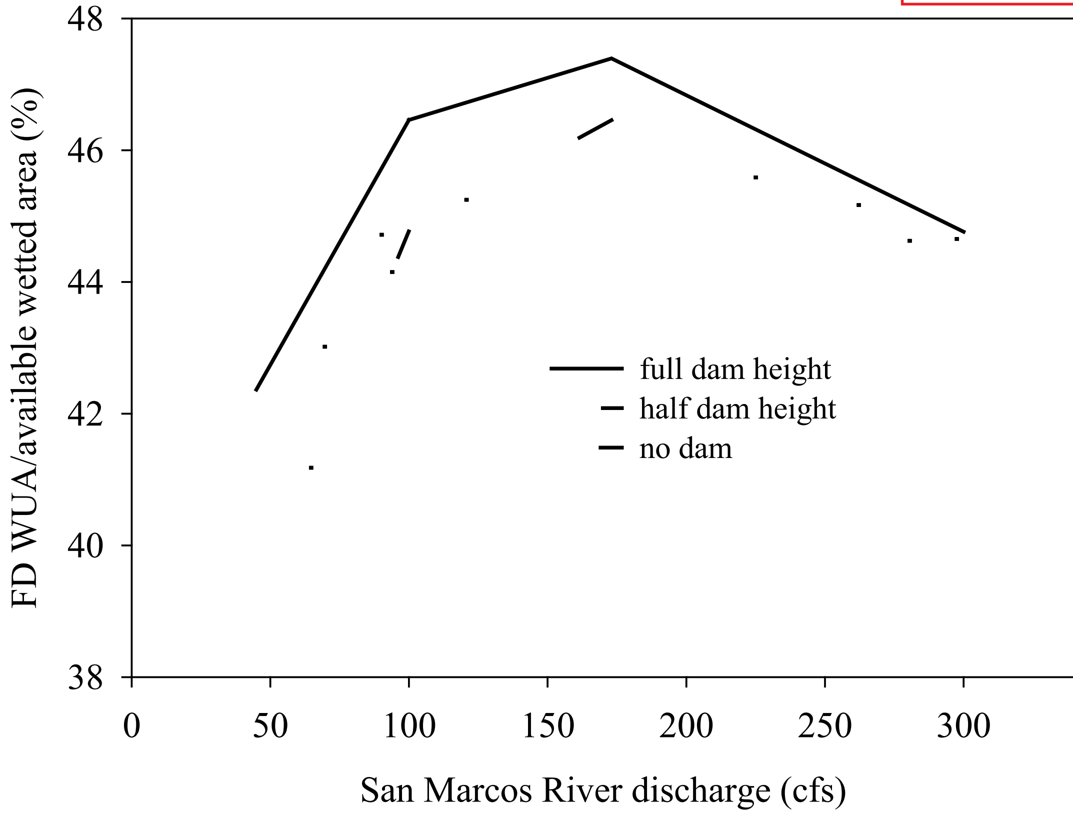

Figure 10. Predicted available fountain darter WUA/available wetted area (%) within the study area of the San Marcos River at discharges of 45, 100, 173, and 300 cfs for three Cape's dam scenarios including full dam height (solid line), half dam height (dash dot dot line), and no dam (dashed line).

This Conclusion section is largely copied & pasted into the June 24, 2015 report sold to the City of San Marcos by Dr Hardy's private company Watershed Systems Group. The only addition to this section in the June 24, 2015 report is to include mention of Habitat Conservation Plan goals.

Discussion and Conclusions

Modeling results suggest that TWR habitat upstream of Cape's Dam would marginally improve under half-height or complete dam removal when compared to existing conditions. Slight increases in TWR habitat under half-height and the no dam scenarios are primarily related to increases in available water depths less than 1.0 meter. Furthermore, increased velocity fields under half-height and no dam scenarios would favor reduction in the accumulation of fine sediments directly attributed to the existing backwater affects of the dam (Stanley and Doyle 2003). Although incremental reductions in fountain darter habitat are suggested by these modeling results, we point out that they do not incorporate the expected increase in aquatic vegetation species such as TWR we believe may occur under the half-height or no dam scenarios. Sunlight attenuation increases with greater depths and suspended solids, resulting in declines of submerged aquatic vegetation growth (Kemp et al. 2004). Therefore, reduced depths and increased current velocities predicted with partial or complete removal of Cape's Dam would likely increase sunlight penetration and consequently promote vegetation growth in more areas. We believe the additive benefit of increased vegetation would likely result in substantial increases in fountain darter habitat.

Even though our modeling results did not suggest substantial increases in TWR or fountain habitat upstream of Cape's dam with the partial or complete removal of the dam, we believe removal of the dam would still be substantially beneficially for several reasons including 1) allow sediment transport

Read this ***Conclusion*** carefully - "Even though our modeling results did not suggest substantial increases in TWR or fountain habitat upstream of Cape's dam with the partial or complete removal of the dam..."
Even though Hardy et a's **2012 modeling** doesn't show a substantial increase in Texas Wild Rice or fountain [darter] habitat, the removal of Capes Dam is *still* recommended.

downstream from Cape's Dam, which currently excludes necessary substrates for aquatic vegetation establishment and 2) restore stream connectivity for fish passage for species such as the fountain darter. *
Restoration efforts to return sediment transport to river systems has involved dam removal. Damming of a river slows current velocities and can cause aggradations of larger substrates upstream of the dam with finer sediments settling over the top (Bednarek 2001). Removal of Cape's Dam would likely reestablish natural current velocities, remove fine sediment accumulation, and restore coarse sediment transport within the San Marcos River, thus providing improved habitat for vegetation growth and expansion. Fish species richness and diversity generally increase in reconnected areas after dam removal, demonstrating recolonization occurred within these areas (Burroughs et al. 2010; Catalano et al. 2007; Bednarek 2001). Removing Cape's dam would reconnect downstream sections of the San Marcos River to the IH-35 reach of the San Marcos River and increase spatial distribution opportunities for species such as the fountain darter.

"would likely" is not a phrase that is commonly used in independent research that is supposed to present the results of independent investigations, not the politically-favored foregone conclusions that the instituion paying for the report would like to have as their desired outcome.

Literature cited

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Catalano, M. J., M. A. Bozek, and T.D. Pellett. 2007. Effects of dam removal on fish assemblage structure and spatial distributions in the Baraboo River, Wisconsin. North American Journal of Fisheries Management 27: 519-530.

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* It is interesting to use a Fish Passage program of the USFWS to "restore stream connectivity" to a specie that does not migrate, and is not impacted by the existence of Capes Dam, only it's removal.

A 2013 report written by the American Fisheries Society by Nathan T Dammeyer et al, "Site Fidelity and Movement of *Etheostoma fonticola* [Fountain darter] with Implications to Endangered Species Management," states, "*Etheostoma fonticola* exhibited high site fidelity, moving on average [33-56 feet] during a 1-year period" See Attachment V, page 1.

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