CHINESE TALLOW SURVEY
STUDY PLAN

TOLEDO BEND RELICENSING PROJECT
FERC PROJECT NO. 2305

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1.0 INTRODUCTION

1.1 General Description of the Toledo Bend Project

The Sabine River Authority of Texas (SRA-TX) and the Sabine River Authority, State of Louisiana (SRA-LA) (collectively, the Authorities) collaborated to develop the Toledo Bend Project (Project) located on the Sabine River. Construction was completed in October 1966. The Project is jointly operated by SRA-TX and SRA-LA through Toledo Bend Project Joint Operations (TBPJO).

The Project was originally planned, licensed, and constructed as a water supply facility, but it also provides multiple uses, such as hydroelectric power generation and recreation. The Project is located approximately 156.5 miles upstream of the confluence of the Sabine River and the Gulf of Mexico. Both the Project and this reach of the river serve as the border between the States of Louisiana and Texas.

The Project reservoir (which is oriented in a southeast to northwest direction), is approximately 85 miles in length. The Project extends approximately 132 river miles (RM) (channel miles) from Toledo Bend Dam, which is located at RM 147,1 upstream to above Logansport, Louisiana (i.e., Murvaul Bayou), located at RM 279. The Project occupies lands and waters within Panola, Shelby, Sabine, and Newton counties in Texas and De Soto, Sabine, and Vernon parishes in Louisiana. Toledo Bend Reservoir is the largest manmade body of water in the southern United States and the fifth largest in surface area in the country.

The reservoir has approximately 1,200 miles of shoreline with a water surface area of 185,000 acres at the normal maximum reservoir elevation of 172.0 feet mean sea level (msl). The Toledo Bend Reservoir is 7 miles at its widest point and contains a storage volume of 4,477,000 acre-feet between elevations 162 feet and 172 feet. Primary hydroelectric generation occurs between 168 and 172 feet. The watershed above Toledo Bend Dam is approximately 7,178 square miles

[1] River Miles (RM) are measured along the river starting at the confluence of Sabine Lake and the Sabine River.

with an estimated runoff in 2004 of 3.6 million acre-feet (SRA 2008). Over its history, water levels have ranged from a low of 161.3 feet msl to a high of 173.9 feet msl.

As currently licensed, the principal Project works consist of:

- A rolled earth-fill dam with a maximum height of 112 feet and a length of 11,250 feet (including saddle dikes);
- A reservoir with a surface area of 185,000 acres and 1,200 miles of shoreline with an active storage capacity of 4,477,000 acre-feet;
- A concrete gravity spillway located on the left abutment (in Louisiana) with a gated ogee section and a concrete chute and stilling basin. The spillway has a maximum length of 838 feet with eleven 40-foot by 28-foot Tainter gates. The top of the gates is at elevation 173 feet and top of the spillway ogee is at elevation 145 feet. A continuous flow of 144 cubic feet per second (cfs) is provided at the spillway;
- A powerhouse located at the right abutment (in Texas) containing two 58,500 horsepower (43.875-MW) vertical Kaplan turbines with direct drive generators, a tailrace channel, and appurtenant electrical and mechanical facilities.

1.2 Relicensing Process

The current Toledo Bend license extends to September 30, 2013. The Authorities intend to relicense the Project using the Integrated Licensing Process (ILP) as promulgated by Federal Energy Regulatory Commission (FERC) regulations issued July 23, 2003 (18 CFR Part 5).

Pursuant to the FERC ILP regulations, the Authorities filed their Pre-Application Document (PAD) and Notice of Intent (NOI) with FERC on September 22, 2008. Following the Authorities' filing of the PAD and NOI, FERC issued Scoping Document 1 (SD1) on November 21, 2008, and convened scoping meetings and a site tour for agencies and members of the public on December 16 – 17, 2008. Resource agencies and other stakeholders had until January 21, 2009 to submit comments on the PAD and study requests. The Authorities received comments and study requests from six resource agencies, one non-governmental organization, and FERC staff. In total, requests were submitted for forty-four studies, including several requests for studies related to aquatic resources and Project operations modeling. The Authorities carefully

reviewed the study requests and developed Proposed Study Plans, which were filed with the FERC on March 9, 2009.

On March 25, 2009, the Authorities held the required Proposed Study Plan Meeting with the agencies and stakeholders. Based on the comments and recommendations from this meeting and other stakeholder meetings, the Authorities prepared an updated Proposed Study Plan that was distributed for review and comment on May 27, 2009. Relicensing participants, including FERC staff, then filed comments on the updated Proposed Study Plans with FERC on June 8, 2009.

Based on those comments and Working Group meeting discussions, the Authorities completed Revised Study Plans. The SRA had until July7, 2009 to file this and the other Revised Study Plans with the FERC.

The Commission's study plan determination (August 6, 2009) largely approved the Authorities' RSP, although based on concerns expressed by the USFS the Commission expanded the scope of three studies and imposed a new study not included in the Authorities' RSP. The Commission's study plan determination requires the following relicensing studies and investigations:

- *Recreation Use and Needs Assessment.* This study was first proposed by the Authorities in their original PSP and refined during the consultation and comment period. When approving this plan, the Commission modified it to include the identification and characterization of any impacts of erosion and/or sedimentation to recreation facilities or recreational access.

- *Terrestrial Special Status Species Assessment*. This study was first proposed by the Authorities in their original PSP and refined as a result of comments, meetings, and other consultation with resource agencies. When approving this study plan, the Commission – in response to concerns expressed by the USFS – expanded it to include an evaluation of noxious terrestrial plant species, including Chinese tallow.

- *Lower Sabine River Water Quality and Aquatic Resources Study.* Elements of this study were originally proposed by the Authorities in their original PSP, but the

Commission-approved plan was developed after extensive consultation among the Authorities and resource agencies.

- *Cultural Resources Study.* This study was first proposed by the Authorities in the original PSP, but was modified significantly during consultation with the USFS, Louisiana and Texas State Historic Preservation Officers, and Indian tribes. When approving the final plan, the Commission responded to several remaining concerns expressed by the USFS in its comments on the RSP, including the meaning of several terms used in the study plan and the proposed methodology for subsurface testing.

- *Indian Mounds Wilderness Assessment Study.* This study, first proposed by the USFS, was included in the Authorities' PSP, and then later revised in the RSP in response to additional comments on this study submitted by the USFS. The Commission approved the study plan without modification.

- *Soil Erosion Study.* In response to the USFS's request for a soil erosion study, the Commission's study plan determination imposed a new study – not proposed by the Authorities – to inventory the extent of shoreline erosion around the perimeter of the Toledo Bend Reservoir, and to identify any resulting resource effects of such erosion. The study plan required by the Commission, however, does not include certain elements requested by the USFS, including an investigation of the reasons for erosion along the Reservoir or the development of a predictive model to estimate future erosion.

The Commission's study plan determination also explained its reason for not adopting certain studies requested by the USFS, including the following:

- *Noxious Weeds (Chinese tallow) Study.* In not adopting this as a stand-alone study plan, the Commission explained that it was requiring the Authorities to conduct focused surveys of invasive terrestrial species as part of field investigations conducted in the Terrestrial Special-Status Species Assessment. In addition, the Commission imposed a requirement for the Authorities to record the location of Chinese tallow as part of the fieldwork conducted in all relicensing studies.

- *Project Boundary (LIDAR/GIS Baseline) Study Plan.* In not adopting this proposed study, the Commission explained that its regulatory requirements for establishing the Exhibit G Project boundary through metes and bounds surveys are sufficient for it to meet its responsibilities for administering the license for the Project.

- *Land Encroachments Study Plan.* In not adopting this proposed study, the Commission explained that any existing encroachments on USFS-administered lands within the Project boundary are addressed by the Commission's Division of Hydropower Compliance and Administration. The Commission also explained that a shoreline management plan developed as part of the relicensing effort may help prevent and curtail any such encroachments during the new license term.

- *Soil Erosion Study.* While the Commission did not adopt the soil erosion study requested by the USFS, it explained that it did require the Authorities to undertake a study to assess any erosional impacts associated with the Project.

Following the Commission's issuance of its study plan determination, the USFS, pursuant to Section 5.14(a) of FERC's ILP regulations, filed a notice of study dispute concerning several studies. Specifically, the USFS sought dispute resolution on the following studies:

- Terrestrial Special Status Species
- Cultural Resources
- Non-Native Invasive Plant Species (Noxious Weeds) (Chinese tallow)
- Project Boundary
- Encroachment and Trespass
- Soil Erosion

By letter dated September 18, 2009, the USFS further addressed its dispute with the Commission's study plan determination and set forth specific conditions that would need to be incorporated into each disputed study in order to resolve the USFS's concerns. Several of these conditions were associated with the Chinese tallow. The conditions specifically stated include:

- Sabine River Authority (SRA) has proposed a study to determine the current extent of the Chinese tallow infestation within the Toledo Bend Reservoir project nexus. We agree this can be achieved in a multitude of ways, including satellite imagery (i.e. USGS study), infrared spectral analysis, aerial interpretation, and ground surveys. However, some type of survey must be performed and the survey results must be ground-truthed.
- This study must delineate the current extent of Chinese tallow infestations, which will be used to establish future management actions for controlling and/or eradicating non-native invasive species both on FS lands and on adjacent lands.
- The information on Chinese tallow is needed to develop a management plan to initially reduce the occurrence of Chinese tallow with the goal of eradicating it off of FS administered lands within the next license term. If no study plan is adopted, then this issue needs to proceed to the Dispute Resolution Panel.
- We agree to drop our dispute regarding aquatic invasive species.

The following study plan reflects the conditions stated above.

2.0 GOALS AND OBJECTIVES

The goals of the study are as follows:

- Provide a realistic and accurate study that will determine the current extent and distribution of Chinese tallow infestations within the Toledo Bend Project Boundary and adjacent lands affected by Project operations and maintenance.
- Determine the extent and distribution of Chinese tallow in the general region surrounding the Toledo Bend Project.

This study will be based on the mapping of Chinese tallow with the Earth Observing 1 (EO1) Satellite Hyperion[2] hyperspectral image data. An additional component of the study will

[2] Hyperion collects 220 unique spectral channels ranging from 0.357 to 2.576 micrometers with a 10-nm bandwidth. The instrument operates in a pushbroom fashion, with a spatial resolution of 30 meters for all bands. The standard scene width is 7.7 kilometers. Standard scene length is 42 kilometers, with an optional increased scene length of 185 kilometers. U.S. Geological Survey Website http://edcsns17.cr.usgs.gov/eo1/lookAngles.php.

include the mapping of surface aquatic vegetation (including species such as water hyacinth and giant salvinia) within the Toledo Bend Reservoir.

3.0 STUDY AREA

The study area for the Chinese tallow survey will include all lands within the Project Boundary and those lands affected by Project operations and maintenance. The study area will also include all the lands within the US Forest Service's Sabine National Forest and adjacent regional lands to the east and west of the Project.

4.0 BACKGROUND AND EXISTING INFORMATION

In review of several databases and existing literature, Chinese tallow has been documented in the Project area throughout the Texas counties of Panola, Shelby, Sabine, and Newton including a large number of areas within the Project Boundary and USFS lands. The species has been documented, as well, in Orange County downstream of the Project and all the adjacent East Texas counties. In the Louisiana portion of the Project area, the species has been documented throughout Vernon, Sabine, and De Soto parishes. Tallow has also been documented in Louisiana, downstream of the Project, in Beauregard, Calcasieu, and Cameron parishes. During the PAD Bottomland Study, tallow was documented in several of the bottomland floodplain vegetation transects (especially within several oxbow lakes) along the lower Sabine River.

Chinese tallow is a highly competitive invasive tree that quickly out-competes many native trees and shrubs. Chinese tallow will transform native habitats into monospecific (single species) tallow forests in the absence of land management practices. Chinese tallow alters light availability for other plant species. Fallen tallow leaves and the plants themselves also contain toxins that create unfavorable soil conditions for native plant species (i.e., allelopathic - produces phytotoxins that inhibit the germination and growth of other plant species). The species invades stream banks, forested wetlands, riverbanks, and wet areas like ditches as well as upland sites. It can thrive in both freshwater and saline soils and is shade tolerant, flood tolerant, and

allelopathic (i.e., produces phytotoxins that inhibit the germination and growth of other plant species). The species is spread by bird- and water-dispersed seeds and colonizing by prolific surface root sprouts (Texasinvasives.org).

It has been demonstrated that Chinese tallow could be mapped, in the Coastal Plain of Texas and Louisiana, during fall senescence when their red leaves contrast with the matrix of native vegetation (Ramsey et.al. 2002). Ramsey et al. (2002) showed that high spatial resolution (0.5-m color infrared photography) was necessary to map successfully and directly Chinese tallow, which most often occurred as narrow and small fragmented stands; the mapping was local and required high costs in time and personnel. To obtain regional coverage at reasonable costs, Ramsey and Nelson (2005) and Ramsey et al. (2005, 2005a) used Earth Observing 1 (EO1) satellite Hyperion hyperspectral image data. The challenge was to detect low subpixel occurrences of Chinese tallow with the coarser Hyperion spatial resolution image data. To provide this subtle distinction, the apparent reflectance provided by the Hyperion data, was transformed into the best estimate of the actual canopy reflectance at the time of the image collection (Ramsey and Nelson 2005). After accurate spectral detail was obtained, a spectral subpixel-extraction algorithm operating on a Hyperion atmospherically corrected and normalized canopy reflectance spectra dataset (n=34) was used to provide realistic and predictive characteristic spectra (Ehrlich 2000, Johnson et al. 2002, Ramsey et al. 2005). Ramsey et al. (2005a) then related the extracted characteristic spectra to the occurrence of pertinent and dominant land cover spectral characteristics that existed at the time of the Hyperion image data collection.

Five characteristic spectra extracted from the Hyperion image dataset were found to be significantly related to canopy compositions of (1) trees with 'senescing (browning) foliage', including cypress tupelo trees, (2) green vegetation, (3) canopy shadows, (4) trees with 'yellow foliage', including Chinese tallow with yellow leaves, and (5) Chinese tallow with red leaves, hereafter referred to as 'red tallow' (Ramsey et. al. 2005). Following results uncovered in the characteristic spectra validation, green vegetation compositions were produced by combining the percent occurrences of green vegetation and canopy shadows, which had been predicted separately by their respective characteristic spectra. The combined shadows and green vegetation

characteristic spectra explained 92% (n=34 field sites) of the observed green vegetation; the senescing foliage characteristic spectra explained 86% (n=34 field sites) of the observed senescing foliage; and, although the correlation was significant (p=0.10), the yellow foliage characteristic spectra explained little of the variability of the observed yellow tallow canopy composition at the time of the Hyperion image collection (Ramsey et al. 2005). The red tallow characteristic spectra explained 78% (n=34) of the observed red tallow occurrences at the time of the Hyperion image collection. Regression confidence limits suggested that red tallow occurrence comprising 10% and 15% of the 30-m Hyperion pixel were detected 68% and 85% of the time, respectively (Ramsey et al. 2005). These detection levels are equivalent to a contiguous stand or scattered occurrences comprising less than 10 m by 10 m and 12 m by 12 m areas, respectively, of the 30 m by 30 m pixel (i.e., Hyperion sensor spatial resolution).

The percent occurrences of green, senescent, and tallow vegetations were then produced throughout the entire Hyperion image coverage by applying the validated green, senescent, and tallow characteristic spectra to the entire Hyperion reflectance image (Ramsey et al. 2005a). In addition to the validation of the green, senescent, and tallow percent occurrence images by comparison to field percent observations, tallow occurrences were further validated by visual comparison to oblique photography obtained at non calibration sites (Ramsey et al. 2005a). Validations and derived detection limits confirmed that this method can be used to detect and monitor the establishment and spread of Chinese tallow.

The Texas Agricultural Experiment Station, part of the Texas A&M University System, evaluated eight different Chinese tallow control techniques for effectiveness and cost efficiency. These methods included herbicide treatments, manual removal (hand pulling and cutting), and burning. The herbicides Roundup, Arsenal AC, Pathfinder II and Garlon 3A were used in killing at least 92% of the Chinese tallow. Tallow seedlings were also treated by hand pulling and burning and were reduced by 90% in the first year. This resulted in a temporary density reduction as seedling densities returned to pretreatment levels within 22 months. The study determined that while the trees and seedlings can be killed with several methods, the control of this species is short-lived, localized, and expensive. With older trees, hand pulling is ineffective

since the species will just resprout. A dense forest canopy of native trees species is the best method to control the spread of the Chinese tallow tree (Texas A&M 2001).

5.0 PROJECT NEXUS

Although found throughout the region and upslope of the Toledo Bend reservoir, the operation of the Toledo Bend Project may have an effect (in part) in the spread of the Chinese tallow. The existence of tallow can affect native botanical and wildlife resources, as well as land use. This study will provide the data and analyses necessary to determine the extent and distribution of the Chinese tallow in the Project area and adjacent lands.

6.0 METHODOLOGY

The following methods and procedure are provided by Ramsey and Nelson (2005), Ramsey et al. (2005 and 2005a). This study will follow these methods as detailed below. Outside contractors (Remote Sensing Specialist, IAP World Services, Inc. and the USGS) will be used for this study. NOTE: specific methods may be revised upon consultation with the USGS.

The NASA's Earth Observing 1 (EO1) satellite will be specifically tasked to collect Hyperion and Advanced Land Imager (ALI)[3] sensor image data covering the Project area (Figure 1). Collection will take place from about mid October to mid to late November 2009 during the autumn senescing period of Chinese tallow. ALI image collections will occur simultaneous to every Hyperion image collection. The ~7.6 km Hyperion swath will be centered aligned on the ~37 km ALI swath (Figure 2). Priorities assigned to each Hyperion swath (Figure 1) will provide the NASA tasking coordinator a collection priority strategy incase cloud presence diminishes collection frequency. A 100% collection of useable Hyperion image data will provide two collections per Hyperion swath over the collection period. Persistent cloud

[3] **Advanced Land Imager** provides image data from ten spectral bands designed to mimic six Landsat bands with three additional bands covering 0.433-0.453, 0.845-0.890, and 1.20-1.30 µm. The instrument operates in a pushbroom fashion, with a spatial resolution of 30 meters for the multispectral bands and 10 meters for the panchromatic band. The standard scene width is 37 kilometers. Standard scene length is 42 kilometers, with an optional increased scene length of 185 kilometers.

occurrence and emergency redirection of the EO1 satellite are the greatest impediments to successful mapping of Chinese tallow occurrences.

Collected EO1 Hyperion hyperspectral data will provide the subtle spectral discrimination necessary for detecting canopy red Chinese tallow occurrences. To obtain the necessary spectral detail, the Hyperion image data will be calibrated to absolute units, corrected for atmospheric influences, and normalized by the downwelling sunlight (Ramsey and Nelson 2005).. This transformation of the Hyperion image's apparent reflectance into accurate estimates of the canopy intrinsic reflectance will be obtained by combining field canopy reflectance data (see Footnote 5) and a radiative transfer atmospheric model (Ramsey and Nelson 2005). These final canopy reflectance spectra estimates will be smoothed by using a spectral filter to diminish noise, and finally, restricted to wavelengths between about 400 nm and 925 nm most pertinent to tallow detection. The target canopy reflectance spectra accuracy is ±1% in the visible wavelength range (400 nm to 700 nm) and ±5% in the near-infrared wavelength range (700 nm to 925 nm). Spectral reflectance accuracy assessment will be produced by comparison of the field and Hyperion reflectance spectral data[4].

Canopy reflectance spectra extracted from the Hyperion reflectance image at the field site locations will be used to perform the characteristic spectra creation (Ramsey et al. 2005). Characteristic spectra will be created for red Chinese tallow and other dominant canopy vegetations, most likely green (including shadows) and senescing foliages. Calibration of the characteristic spectra will be performed by comparing canopy composition percentages observed at the field sites to percent compositions predicted by applying the characteristic spectra to the

[4] Field collections, analyses, and validation will follow published methods (Ramsey and Nelson 2005, Ramsey et al. 2005). Three ground-based field surveys will be scheduled in cooperation with the Toledo Bend Project Joint Operations management. These ground-based surveys will locate calibration and validation field site locations. Helicopter-based radiometric collections will occur up to two times during the EO-1 satellite collection period. During the helicopter collections, a similarly calibrated ground-based radiometer will collect sunlight downwelling measurements. The ground-based radiometric collections will be used to transform the helicopter-based measurements to canopy reflectance estimates.

Hyperion reflectance data (Ramsey et al. 2005). The same field sites will be used to estimate canopy composition prediction accuracy and set composition detection limits. At the field sites,

50 percent of the sites will be used for initial signature and 50 percent of the sites will be used for accuracy assessment. The validated characteristic spectra will be applied to the entire Hyperion image coverage throughout the Project area (Ramsey et al. 2005a). The same characteristics are expected to be used throughout the study period. Created percent occurrences associated with the derived characteristic spectra (i.e., tallow, green and senescing foliages) extracted from the transformed Hyperion image data will be compared to field observed compositions as a check of transformation integrity. This comparison will ensure that parameters that were generated from the limited calibration dataset linked to field data collections will be accurately transferred to the whole Hyperion image. Digital oblique photography obtained during the helicopter flights will be used to provide a final visual confirmation of tallow occurrences and patterns predicted by the transformed Hyperion reflectance images (Ramsey et al. 2005a).

7.0 DATA ANALYSIS AND REPORTING

Based on this analysis, results (aerial figures and associated graphs, and GIS coverage) will be provided that depict the areal extent and distribution of Chinese tallow in the study area, including areas of the highest concentration. An additional component of the study will include the mapping of surface aquatic vegetation (including species such as water hyacinth and giant salvinia) within the Toledo Bend Reservoir.

The Draft and Final technical report on the results of the literature review, analysis, and recommendations will include the following elements:

- Project Introduction and Background
- Study Area
- Methodology
- Discussion and Analysis
- Results
- Location maps, GIS analysis and photos

- Any agency correspondence and or consultation
- Literature Citations

The study reports will also provide recommendations for future water quality sampling/monitoring protocols and possible sites for installing continuous water quality monitoring equipment for Section 401 compliance.

Initial and Updated Study reports will be submitted to the following agencies:

- Federal Energy Regulatory Commission
- United States Forest Service
- Texas Parks and Wildlife Department
- Louisiana Department of Wildlife and Fisheries
- United States Fish and Wildlife Service
- Other interested stakeholders

8.0 SCHEDULE

The preliminary schedule to conduct this Study is outlined below:

1. Study Planning and Data Review Commences: October 15, 2009
2. NASA EO1 Satellite Imagery Taken: October-November, 2009
3. Data Analysis: December 2009-February 2010
4. File Progress Report (Authorities): March 3, 2010
5. File Initial Study Report (Authorities): October 30, 2010
6. Initial Study Report Meeting (Authorities and Stakeholders): November 15, 2010
7. File Study Report Meeting Summary (Authorities): November 30, 2010
8. File Meeting Summary Comments (Authorities): December 30, 2010
9. File Response to Meeting Summary Comments (Stakeholders): January 28, 2011
10. Study Plan Resolution/Amendments by FERC: February 28, 2011

9.0 BUDGET

The estimated budget for the Chinese tallow survey is approximately $122,000.

10.0 DISCUSSION OF ALTERNATIVE APPROACHES

The proposed methods for this study are consistent with professional resource practices and consist of proven state of the art technology. No alternative measures have been identified at this time.

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