# TABLE OF CONTENTS

1.0 INTRODUCTION .......................................................................................................................... 1

2.0 METHODS ................................................................................................................................. 1
  2.1 Desktop Aerial Imagery Assessment .......................................................................................... 1
  2.2 Aerial Reconnaissance ............................................................................................................. 2
  2.3 Field Reconnaissance ............................................................................................................... 2

3.0 RESULTS ...................................................................................................................................... 2
  3.1 Desktop Aerial Imagery Assessment .......................................................................................... 2
  3.2 Aerial Review .......................................................................................................................... 3
  3.3 Field Review ........................................................................................................................... 3
    3.3.1 Hydrologic Conditions ....................................................................................................... 3
    3.3.2 Soil Impacts ....................................................................................................................... 3
    3.3.3 Vegetation Impacts ............................................................................................................ 4
    3.3.4 Seismic Survey Operations ............................................................................................... 6

4.0 DISCUSSION ............................................................................................................................... 6
  4.1 Anticipated Long-Term Impacts ............................................................................................... 7
    4.1.1 Hydrology .......................................................................................................................... 7
    4.1.2 Vegetation .......................................................................................................................... 8
    4.1.3 Fire Behavior ..................................................................................................................... 9
    4.1.4 Future Recreational ORV Use .......................................................................................... 9
  4.2 Recommendations for Restoration, Maintenance and Monitoring ......................................... 9
    4.2.1 Restoration Success Criteria Recommendations ............................................................. 11
    4.2.2 Maintenance and Monitoring Recommendations ............................................................ 12

5.0 CONCLUSION ............................................................................................................................ 13

# FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Location Map</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Phase I Seismic Survey Impact Observations from 2018 Field Inspections</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Approximate Seismic Survey Impact Observations from Google Earth© Imagery</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Florida Panther Occurrence Records in and around Phase I Seismic Survey Boundary</td>
</tr>
</tbody>
</table>

# APPENDICES

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appendix A</td>
<td>Photo Documentation of “Seismic Survey Line A” Conditions as of 4/26/18</td>
</tr>
<tr>
<td>Appendix B</td>
<td>Photo Documentation of “Seismic Survey Line B” Conditions as of 4/26/18</td>
</tr>
</tbody>
</table>
1.0 INTRODUCTION

In April 2018, the Natural Resources Defense Council (NRDC) requested Quest Ecology Inc. (Quest) to assess compliance and document impacts associated with the Burnett Oil Company, Inc.‘s (BOCI) Phase I of the Nobles Grade 3-D Geophysical Seismic Survey (seismic survey) in the Big Cypress National Preserve (Preserve).

The primary documents that authorize the seismic survey and establish compliance requirements for the survey operations are listed below:

- U.S. Department of the Interior, National Park Service, Finding of No Significant Impact, Nobles Grade 3-D Seismic Survey Big Cypress National Preserve (May 2016), (hereinafter, FONSI) and Conditional Approval of Burnett Oil Company, Inc. Nobles Grade 3-D Seismic Survey Plan of Operations, Big Cypress National Preserve, Florida (May 2016)
- Oil & Gas Geophysical Permit No. G-173-17, issued 12/14/17 by the Florida Department of Environmental Protection (FDEP) to BOCI. Expires 12/14/18 (hereinafter, Geophysical Permit)
- Environmental Resource Permit No. 11-0323836-002, issued July 15, 2015 by FDEP to BOCI. Expires July 15, 2020 (hereinafter, Environmental Resource Permit or ERP)

The following observations and comments are based on April 26 & 27, 2018 field and aerial reviews of BOCI’s Phase I seismic survey area, see Figure 1, attached hereto and incorporated herein, supplemented with findings from prior site assessments conducted by Quest in June and July, 2017, and a desktop analysis of the most recent Google Earth© aerial imagery for the seismic survey area that captures the magnitude of BOCI’s impacts as of 5/27/17, approximately two months after Phase I seismic survey activities began.

The most recent field and aerial reviews were conducted by Mary James, PWS, and Chris Keene of Quest, and John Meyer, PWS, collectively representing 48 years of professional experience as Florida ecologists (hereinafter, Inspection Team). Quest personnel conducted similar reviews of the Phase I seismic survey activity and impacts in 2017, results of which were documented in Technical Review of Wetlands, Wildlife, Vegetation and Habitat Aspects of Phase I Burnett Oil Company Nobles Grade 3-D Seismic Survey, Big Cypress National Preserve, August 2017.

2.0 METHODS

2.1 Desktop Aerial Imagery Assessment

To estimate the acreage of impacts from BOCI’s seismic survey activities, seismic survey lines were identified utilizing Google Earth Pro™ (Google Earth) aerial imagery. By using the timeline tool in Google Earth, past and present aerial imagery of the Preserve were reviewed and compared. For BOCI’s Phase I Seismic Survey Area, the two most recent Google Earth imagery dates are 2/17/14 and 5/27/17. Since BOCI’s seismic survey activities began on or about 3/22/17, we are able to compare aerial imagery from before and approximately two months after seismic surveying commenced. Seismic survey lines were identified using a side-by-side comparison of the 2/17/14 and 5/27/17 aerial imagery. Seismic survey lines appeared on the 2017 imagery that were not present on the 2014 imagery. By using the “add a path”
feature in Google Earth, the seismic survey lines shown on Figure 3, attached hereto and incorporated herein, were delineated, then exported into GIS software which allows for accurate measurements and provides GPS coordinates. Quest’s field survey identified typical seismic survey line widths between 12 and 15 feet. By multiplying these widths by the seismic survey line lengths calculated in GIS software, we calculated an approximate range of acreage impacted by the Phase I 2017 seismic survey activities as of 5/27/17. Note the full extent and nature of the Phase I seismic survey activities is unknown at this time because seismic survey activities resumed in early 2018.

2.2 Aerial Reconnaissance

On 4/26/18, the Inspection Team and a pilot departed from the Everglades City Airport at approximately 1000 hours in a 4-passenger plane. The plane flew east along U.S. Route 41, then turned north-northeast near the Preserve’s Oasis Visitor Center. See Figure 1. The flight path included the Phase I seismic survey boundary, entering near its southeast corner, then flying northwest, traversing the approximate center of the survey area on a northwest-southeast axis. Just south of the intersection of Interstate 75 (I-75) and the northwest Phase I seismic survey boundary, the flight path turned south, then southwest, returning to the Everglades City Airport at approximately 1130 hours. Minor deviations in the general flight path described above occurred as areas of potential seismic survey activity or impacts were observed.

2.3 Field Reconnaissance

The Inspection Team arrived at the I-75 Mile Marker 63 (MM 63) rest area at approximately 1330 hours on 4/26/18, and entered the Preserve on foot by hiking south on the Florida National Scenic Trail (Florida Trail) for approximately 0.15 mile before turning west along “Seismic Survey Line A” (see Figure 2, attached hereto and incorporated herein, Photostation 8), which is a seismic survey line previously inspected by Quest on 6/15/17. Upon reaching the western terminus of Seismic Survey Line A (Figure 2, Photostation 12), the Inspection Team hiked generally south for approximately 0.25 mile until intersecting “Seismic Survey Line B” near Photostation F, shown on Figure 2. Seismic Survey Line B was identified and mapped as a target destination utilizing Google Earth 5/27/17 aerial imagery prior to the field inspection. Seismic Survey Line B was chosen among many 2017 seismic survey lines evident on the 5/27/17 Google Earth imagery because a convoy of five “vibroseis” vehicles used to generate seismic signals was visible near the seismic survey line’s western terminus in a dense cypress swamp (Figure 3).

Upon intersecting Seismic Survey Line B, the Inspection Team turned west, following the seismic survey tracks to Photostation O shown on Figure 2. The Inspection Team returned east along Seismic Survey Line B until intersecting the Florida Trail, then turned north and hiked back to the MM63 rest area. GPS locations of photostations and other points of interest along the routes traversed were documented using the Avenza© application. Geo-rectified aerial maps of the Preserve, the Phase I seismic survey area boundary, seismic survey lines, and National Park Service designated off-road vehicle (ORV) trails were imported to the application prior to the site inspection to facilitate navigation. See Figures 1 and 2.

3.0 RESULTS

3.1 Desktop Aerial Imagery Assessment

Figure 3 was created to present a visual representation of seismic survey lines present as of 5/27/17, approximately two months after Phase I seismic survey activities commenced. Seismic survey lines are
represented by gray lines, and ORV trails designated by the National Park Service are represented with orange lines. It is important to note that the seismic survey lines shown on Figure 3 only encompass impacts as of 5/27/17. The nature and extent of the Phase I seismic survey impacts are greater than shown on Figure 3, since Phase I seismic survey activities resumed in early 2018. A more comprehensive estimate of Phase I seismic survey impacts can be provided as newer aerial imagery becomes available.

Using the methods described in Section 2.1 above, approximately 225,896 linear feet (42.8 miles) of seismic survey lines were created by BOCI as of 5/27/17. Using the typical minimum seismic survey line widths of 12 and 15 feet measured by Quest in the Preserve, the minimum area impacted from seismic survey lines as of 5/27/17 is between 62.2 and 77.8 acres. These minimum impact acreages are not all-inclusive because they do not account for areas where seismic survey lines were greater than 15 feet wide, which occurred in areas observed in the field as a result of vibroseis vehicles getting stuck and turning around. (See Appendix B, Photo 5). Most of these impacts occurred in previously roadless areas through high quality wet prairie and dwarf cypress strand wetland communities.

### 3.2 Aerial Review

At the time the flight occurred, minimal seismic survey activity was detected. However, survey activity was observed near the southern portion of the Phase I boundary where a crew of approximately six workers wearing high-visibility vests were observed working around a vehicle. Additionally, helicopters were observed performing aerial lifts of orange bags suspended by slings (presumably containing seismic survey receiver equipment) flying within or near the Phase I seismic survey boundary. Similar helicopter activity was also observed later in the day (See Section 3.3.4 below) at the I-75 MM70 and MM63 rest areas, where orange bags were observed being transported by helicopter or staged for deployment. During the flight, wetland impacts caused by the seismic survey activities were observed, such as the creation of seismic survey lines through dwarf cypress and wet prairie communities. Dozens of cut cypress stumps were also observed from the air at one location in the southern portion of the Phase I boundary. These stumps were located along the margin of a cypress dome, and appeared as a cluster of distinctive, orange-colored disks from the air.

### 3.3 Field Review

#### 3.3.1 Hydrologic Conditions

Hydrologic conditions in the Preserve on 4/26/18 were extremely dry compared to conditions observed during the 6/15/17 inspection when most areas traversed had 4 to 20 inches of standing water. No standing water or saturated soils were observed along BOCI seismic survey lines inspected on 4/26/18, enabling an unobstructed view of soil and vegetation impacts from 2017 seismic survey activities.

#### 3.3.2 Soil Impacts

Observations of soil disturbance created by BOCI’s 2017 survey activities were extensive along the seismic survey lines traversed by the Inspection Team on 4/26/18. See Appendices A and B for photos from Seismic Survey Lines A and B, respectively, and Figure 2 for photostation locations. Soil ruts and ridges of varying depths and heights were continuously present along the seismic survey lines inspected, with the worst damages observed along Seismic Survey Line B. Differences in the degree of impact observed along Seismic Survey Lines A and B appear to be due to a higher sand content in the marl soils underlying Seismic
Survey Line A, compared to the marl soils underlying Seismic Survey Line B. This hypothesis is supported by the lighter-colored soils visible on Google Earth aerial imagery surrounding Seismic Survey Line A, and the higher density of cypress trees (Taxodium sp.) in the vicinity of Seismic Survey Line B versus the predominance of herbaceous wet prairie in the vicinity of Seismic Survey Line A. For these two community types, dwarf cypress density and susceptibility to soil rutting are known to be positively correlated with the marl:sand ratio in soils (Duever et al, 1981; Duever et al, 1986a; Duever, M.J., pers. comm., 5/8/18).

Observed soil ruts ranged from 1 to 11 inches deep on Seismic Survey Line A, and 1 to 22 inches deep on Seismic Survey Line B, as measured from the bottom of the rut to the top of the adjacent ridge formed by the soil displacement. Average soil rut depth was estimated at 1 to 3 inches on Seismic Survey Line A, and 8 to 10 inches on Seismic Survey Line B. The height differential between adjacent ridges and natural ground appeared slightly less than the differential between the bottom of the rut and natural ground, presumably due to soil displacement occurring on both sides of each rut, and an undetermined amount of soil compaction. Some natural infilling of the ruts on Seismic Survey Line A has occurred since the 6/15/17 inspection. For example, a 17-inch deep rut documented at Photostation 10 on 6/15/17 was measured as 11 inches deep on 4/26/18 (Appendix A, Photo 7). This natural infilling is not expected to continue at the rate observed at the one rut location on Seismic Survey Line A that was measured on 6/15/17 and 4/26/18. Rather, this infilling is the near maximum amount of natural infilling that will occur since the soils have already achieved a stable angle of repose over the past year since the ruts were created.

Out-to-out width of the seismic survey lines measured 12 feet at a minimum. Disturbed seismic survey lines were slightly wider (approximately 15 feet) where ruts were deeper due to greater displacement of soils, as was the case along Seismic Survey Line B. Also, even wider paths of soil disturbance were observed in several locations where vibroseis vehicles apparently re-routed their course due to large cypress stumps, deep ruts, or other unknown reasons (Appendix B, Photo 5).

Other soil impacts include compaction due to the weight of the 33-ton vibroseis vehicles and other off-road vehicles. Additionally, soil chemistry was altered due to removal of vegetation and subsequent exposure of soils to direct sunlight. Natural soil horizons were also disturbed due to churning and rutting of soils which disrupts periphyton communities and subsequent marl production. If not corrected or ameliorated, each of these soil impacts will affect the composition and abundance of the vegetation that recruits and becomes established in these impacted areas.

FONSI Minimization and Mitigation Measure No. 18 require ruts, depressions, and vehicle tracks resulting from field operations to be restored to original contour conditions concurrent with daily operations using shovels and rakes to prevent the creation of new trails. Further, FONSI Minimization and Mitigation Measure No. 22 require soils to be decompacted and returned to match the original grade, and reclamation of impacts was supposed to begin immediately as the survey continued. BOCI’s Environmental Resource Permit Specific Conditions 6, 9, and 12, as well as Geophysical Permit Specific Condition 13, require immediate and/or prompt site reclamation, including regrading of soils, following impact. However, no attempts to restore the soil impacts, including rutting or decompaction, caused by BOCI’s 2017 seismic survey activities were observed.

3.3.3 Vegetation Impacts

Observations made in the Preserve on 4/26/18 confirm that vegetation impacts along the seismic survey lines created by BOCI during its 2017 seismic survey activities were extensive. Within the soil ruts created
by the vibroseis and other off-road vehicles, the coverage of herbaceous groundcover vegetation was estimated to be less than 5%, which was in stark contrast to the dense and diverse herbaceous vegetation layer present in the adjacent, undisturbed wet prairie wetland communities. The minor amounts of herbaceous vegetation regenerating in the seismic survey lines appeared to be native vegetation species present in adjacent, undisturbed wet prairie, but the amount of vegetation coverage in the seismic survey lines was not sufficient to make a comparison of compositional differences between vegetation in disturbed versus undisturbed areas.

No invasive or exotic vegetation species were observed in or adjacent to the seismic survey lines inspected, except for minor amounts of the naturalized bermudagrass (*Cynodon dactylon*) in the vicinity of the Florida Trail. Most notably on portions of Seismic Survey Line A where the soil rutting observed was less severe than the rutting observed along Seismic Survey Line B, groundcover vegetation between soil ruts was relatively intact in places, and approached percent coverage similar to adjacent undisturbed wet prairie. In contrast, the percentage of groundcover vegetation in the areas between ruts on Seismic Survey Line B was less than 5% (See Appendix B), presumably due to deeper soil rutting along this line, compared to Seismic Survey Line A, and increased scalping caused by the vibroseis vehicle undercarriages.

In areas where the seismic survey lines bisected dwarf cypress strands, coarse woody debris from dead cypress trees and stumps was abundant, both within the seismic survey lines, and adjacent to the seismic survey lines. Re-sprouting from broken or injured dwarf cypress trees between and immediately adjacent to seismic survey lines was also observed, especially on Seismic Survey Line A, where soil rutting was less severe than that observed along Seismic Survey Line B, and dwarf cypress strands were less frequently impacted. Some re-sprouting of dwarf cypress was observed along Seismic Survey Line B, but dwarf cypress mortality was generally higher than that observed along Seismic Survey Line A. Scarring of cypress trees growing adjacent to the seismic survey lines was frequently observed, but no evidence of wound paint application was observed, as required by FONSI Minimization and Mitigation No. 17, and Geophysical Permit Specific Condition 13(c).

Specific Condition 6 of the Geophysical Permit requires “dense stands of cypress shall be avoided.” However, stumps from felled dwarf cypress trees and seismic survey lines created through dense cypress were observed and abundant along Seismic Survey Line B (See Appendix B). FONSI Minimization and Mitigation Measure Nos. 17 and 20 required that trimming native vegetation below the height or beyond the width of 36 inches or with a 4-inch or greater truck diameter as measured at breast height would be avoided. However, observations of vegetation removal activities exceeding these dimensions were abundant. The largest dwarf cypress tree stump observed measured 40 inches in diameter (Appendix B, Photo 7), and many dwarf cypress tree stumps in the 0.5 to 2 feet diameter range were also observed. The crowns associated with cypress tree stumps of this size were undoubtedly wider than 36 inches. The Inspection Team made several attempts to locate and reassemble corresponding portions of the cut dwarf cypress tree trunks that were formerly attached to these stumps, where possible. At Photostations G and L, shown on Figure 2, dwarf cypress trees measuring approximately 6.1 and 4.3 inches at diameter breast height (DBH) were cut during BOCi’s 2017 seismic survey activities (Appendix B, Photos 8 and 14).

Cardinal air-plant (*Tillandsia fasciculata*) was observed during the field inspection. This bromeliad is listed as endangered by the state of Florida, pursuant to Chapter 5B-40, Florida Administrative Code. Hundreds of cardinal air-plants were observed attached to dwarf cypress trunks during the site inspection. The dead remains of many other endangered cardinal air-plants were observed along or adjacent to the seismic survey lines inspected. The potential for impacts to other state and federally-listed plant species such as meadow jointvetch (*Aeschynomene pratensis* var. *pratensis*), bracted colicroot (*Aletris bracteata*), Small’s
flax (*Linum carteri* var. *smallii*), and Florida mock gamagrass (*Tripsacum floridanum*), as a result of seismic survey activities is high due to their documented occurrence within similar habitats of the Preserve (Gann et al, 2001-2015), and difficulty of detecting these species amongst the extremely diverse wet prairie groundcover communities during non-flowering seasons.

3.3.4  **Seismic Survey Operations**

Vibroseis trucks and other support vehicles and equipment were observed in wetlands in four locations inside the Phase I seismic survey boundary on 4/26/18. Five vibroseis trucks were parked at Photostation B (See Figure 2 and Appendix B, Photo 2), two vibroseis trucks were parked at Photostation C (Appendix B, Photo 3), and three support vehicles with large tanks were parked at Photostation D (Appendix B, Photos 19 and 20). These vehicles appeared to be parked on plastic tarps in wetlands, but not on a composite mat system as required by Specific Condition 4 of BOCI’s Environmental Resource Permit. Other survey equipment consisting of an antenna, trailer and three utility terrain vehicles (UTVs) was staged at Photostation 9, an upland area at the intersection of Seismic Survey Line A and the Florida Trail (See Figure 2 and Appendix A, Photo 10). However, none of these vehicles were parked on tarps or mats.

Survey-related helicopter activity was observed during both the aerial and terrestrial portions of the 4/26/18 inspection. One helicopter was observed airlifting an orange bag suspended by a sling, and another helicopter was observed airlifting an orange bag from the I-75 MM70 staging area while the Inspection Team was driving east on I-75 to MM63 at approximately 1300 hrs. Several helicopters were also observed flying overhead during the field inspection, some transporting the orange bags suspended by slings, and some presumably returning from unloading the orange bags. These helicopters generally appeared to be flying on a south or southwest axis from both I-75 staging areas. Approximately 30 of the orange bags containing receiver equipment were also observed in the MM63 staging area close to the Florida Trail.

Other survey equipment, including orange bags and/or receivers, were observed during both aerial and ground inspections, and some orange bags are also evident on Google Earth aerial imagery dated 5/27/17. The high visibility of the orange bags from the air suggests that these survey materials can be easily retrieved and removed from the Preserve by BOCI upon completion of survey activities. In contrast, the dozens of receivers observed from the seismic survey lines inspected that were placed in cypress trees or tied to wooden stakes (See Appendix A, Photos 6 and 8) are not readily visible from a distance, raising concerns among the Inspection Team about BOCI’s ability to retrieve all equipment upon completion of seismic survey activities, as required by General Condition 6 of the Geophysical Permit and FONSI Minimization and Mitigation Measure No. 4. The receivers observed presumably represent only a small fraction of the total number deployed. They were generally observed to be linearly established at regular intervals and various angles to the seismic survey lines traversed by the Inspection Team.

4.0  **DISCUSSION**

The review of a small subset of the many seismic survey lines created during 2017 has revealed that extensive damage to soils and vegetation was caused by BOCI’s Phase I seismic survey activities, and there was no evidence of any attempt to restore the damage as of 4/26/18. Also, contrary to the benign portrayal of seismic survey activities in BOCI’s state and federal permit applications and Plan of Operations, the impacts are not temporary or minimal. Rather, BOCI’s 2017 seismic survey activities have left deep scars upon the landscape that will not be easily restored, and are expected to have long-term impacts on Preserve hydrology, soils, vegetation structure and composition, fire behavior, and could
induce future recreational ORV use on the seismic survey trails created. Temporal losses of wetland function have already occurred and will continue to accumulate until BOCI successfully restores the impacted areas. We strongly encourage both the National Park Service and the State of Florida Department of Environmental Protection to require BOCI to compensate for any temporal loss of wetland function resulting from vehicle use, by conducting an equivalent area of wetland restoration elsewhere in the Preserve, to offset the specific functional loss, and to restore an area providing wetland functional benefit equivalent to the wetland functional loss, as required by FONSI Minimization and Mitigation Measure No. 45, Specific Condition 13(e) of the Geophysical Permit, and Chapter 62-345, Florida Administrative Code.

4.1 Anticipated Long-Term Impacts

The extensive soil rutting observed during field inspections is expected to have long-term adverse effects on hydrology, soils, vegetative structure and composition, and fire behavior. BOCI’s creation of seismic survey lines in roadless wetlands in the Preserve is also expected to result in increased, unauthorized recreational ORV use of the seismic survey lines, which will compound the anticipated long-term effects described above, in addition to increasing incidents of wildlife disturbance, widening and deepening of seismic survey lines, and increased litter potential, which will lead to an increased risk of restoration failure. Each of these anticipated impacts are discussed in greater detail below.

4.1.1 Hydrology

The vast network of seismic survey lines created by Phase I of BOCI’s seismic survey will have a significant effect on surface hydrology due to disruption of natural topography caused by the extreme soil rutting like the rutting observed on Seismic Survey Line B. Duever et al (1986b) noted that topography is the primary variable controlling the shape and size of the Preserve’s two primary watersheds that flow east and south, as well as the timing and quantity of runoff. Duever cites two studies that contain calculations of the natural topographic gradient within the Preserve boundary, one reporting a gradient of 6 inches per mile, and the other reporting a gradient of 5 to 10 inches per mile. In view of the deep soil rutting (up to 22 inches along Seismic Survey Line B), and extreme lengths of the seismic survey lines, many of which are oriented perpendicular to subtle topographic gradients, it is reasonable to predict that surface water flows will be affected, and runoff quantities will either increase or decrease depending upon the orientation of seismic survey lines relative to local topography. This phenomenon was also recognized by Duever et al (1985), who stated that “raised roads can severely disrupt surface sheet flow patterns...those perpendicular to flow often act as levees, causing longer and deeper inundation on the upstream side and reduced inundation downstream.” Topographic restoration of the seismic survey lines is expected to be extremely challenging given the vast area affected, the remoteness of the areas affected, the high degree of soil compaction, the intermittent presence of cypress tree stumps and woody debris, and the necessity of conducting the restoration with hand tools rather than heavy equipment. Nonetheless, it is essential that BOCI restore the topography to match the elevations that existed prior to the seismic survey activities, to facilitate growth of desirable, native wetland vegetation, so that wetland function can be restored and sustained in the long-term once the maintenance and monitoring period has concluded. BOCI should not be allowed to proceed with additional seismic survey activities until topographic restoration and initial planting are completed to avoid exacerbation of existing impacts and further sustained loss of wetland function.
4.1.2 Vegetation

Even if topographic restoration of the seismic survey lines and soil ruts is successful, long-term impacts on vegetation structure are inevitable and have already occurred, and the potential for long-term impacts on vegetation composition is high given the susceptibility of these denuded areas to invasion by nuisance and/or exotic plant species, and the likelihood that impacted soils will favor a different suite of species than those that occur in adjacent undisturbed wet prairie. The most significant impact to vegetation structure caused by BOCI’s Phase I seismic survey activities is the extensive mortality of, and injury to dwarf cypress trees (*Taxodium* sp.), a cypress variant unique to extreme south Florida. It is widely recognized among Florida ecologists that dwarf cypress tend to be very old despite their small stature, primarily due to the infertile soils and extreme hydrologic conditions where they grow. Duever et al (1984) reported typical sizes of less than 10 m tall (32.8 ft) with DBH less than 15 cm (5.9 in), which corresponds to the general structure observed by the Inspection Team where seismic survey lines bisected dwarf cypress strands.

Discrete age estimates of dwarf cypress trees are inherently difficult due to their extremely slow growth, but two studies in the region are worth noting. Brown (1984) reported that one dwarf cypress stem with a radius of approximately 0.8 inches (1.6 in diameter) had approximately 60 growth rings, while another with a radius of approximately 0.9 inches (1.8 in diameter) had between 26 and 31 growth rings. Growth rates of dwarf cypress measured by Flohrschtuz (1978) in two study sites near the Preserve ranged widely from 0.04 to 3.25 mm per year (0.0016 to 0.128 in/yr). Based on these growth rates, a tree with a DBH of 4 inches could range in age from 31 to 3,500 years. An early study by Mattoon (1915) based on an evaluation of approximately 300 cypress tree stumps in Maryland and Louisiana, concluded that, on average, one foot of stump diameter was equivalent to 100 years of growth. Although productivity at these sites is undoubtedly higher than in the extreme conditions of the Preserve, Mattoon’s study provides a useful minimum growth rate estimate based on stumpage diameter. The combined results of these studies suggest that BOCI’s seismic survey activities through dwarf cypress strands has resulted in the destruction of hundreds, if not thousands, of trees that cannot be replaced in hundreds of years, and that Minimization and Mitigation Measure Nos. 17 and 20, allowing trimming of native vegetation above the height of 36 inches or with a 4-inch or smaller trunk diameter as measured at breast height, is not adequately protective of extremely old and unique dwarf cypress trees in the Preserve. These dwarf cypress trees are the cornerstone of the Big Cypress ecosystem, providing important roosting sites and refugia from high water levels for birds and other wildlife, essential habitat for endangered bromeliads such as the cardinal air-plant, scratching posts for the endangered Florida Panther (*Puma concolor coryl*), and the Florida Black Bear (*Ursus americanus floridanus*), and a food source for the threatened Big Cypress Fox Squirrel (*Sciurus niger avicennia*), as well as a vast number of other ecosystem services.

Long-term impacts on vegetation composition in the herbaceous wet prairie wetland communities bisected by BOCI seismic survey lines is also anticipated. Due to the minimal regeneration of herbaceous plants observed in the soil ruts on 4/26/18, the potential for invasion of these denuded areas by invasive and exotic vegetative species, such as torpedogras (*Panicum repens*) and Brazilian pepper (*Schinus terebinthifolia*), will remain high until the groundcover layer of vegetation is restored in the disturbed areas. While nuisance and exotic species were not observed in the vicinity of seismic survey lines inspected on 4/26/18, propagules could be easily transported to the newly created seismic survey lines and find adequate conditions for germination and establishment in the absence of competing native vegetation. Even if nuisance and exotic plant species do not establish in the seismic survey lines, a change in vegetation composition is anticipated due to different hydrologic, soil, light and other related conditions created by the soil rutting. Essentially, miles of a foreign microhabitat have been created by the creation
of seismic survey trails and soil rutting that differs significantly from the conditions in adjacent, undisturbed wetlands, and, therefore, present growth conditions suitable to a different suite of plant species and/or plant species with a wide amplitude of tolerances.

4.1.3  Fire Behavior

Closely related to the anticipated long-term impacts on Preserve hydrology, soils, and vegetative structure and composition is an anticipated change in fire behavior due to the seismic survey lines created by BOCI. Fire is the dominant force affecting succession in the wet prairie and cypress strand wetland communities (Duever, 1985), and the miles of seismic survey lines created have the potential to act as fire breaks, thereby reducing the efficacy of both natural and prescribed burns. In the absence of fire management, plant communities on the lee side of a fire break will become more shrub-dominated (Duever, 1985), potentially forming dense canopies that may further impede the progress of fire, or cause fires to burn hotter and longer at these locations due to an abrupt change in fuels from the adjacent graminoid-dominated, undisturbed wet prairies. These localized effects are expected to result in higher mortality of cypress trees growing adjacent to the seismic survey lines, as their fire tolerance will be compromised by the higher intensity fires expected to occur with a shift to primarily woody fuels. The abundance of coarse woody debris left within and adjacent to the seismic survey lines created by BOCI’s crews’ felling of cypress trees will only exacerbate this effect. The localized higher intensity of fires will also affect the composition of the seed bank and recruitment from the seed bank since propagules of native plant species have evolved heat tolerances based on fast-moving fires characteristic of wet prairies with light flashy fuels.

4.1.4  Future Recreational ORV Use

The many miles of new seismic survey lines created by BOCI in a mostly-roadless portion of the Preserve will undoubtedly lead to recreational ORV usage of seismic survey lines in the future, even if they are not officially authorized by the National Park Service and despite any efforts to block these areas from use. Geophysical Permit Specific Condition No. 12 requires the installation of signs, barriers, or similar access deterrents to prevent ORV use of seismic survey line routes. However, no signs or barriers deterring recreational ORV usage of the seismic survey lines were observed during the 4/26/18 inspection. Even if such barriers were in place as required, it is anticipated that some recreational ORV users will not be deterred by barriers, and will utilize the seismic survey lines to access formerly inaccessible portions of the Preserve. Such unauthorized ORV use will further compound the soil and vegetation impacts described herein, lead to increased litter and disturbance to wildlife, and may thwart any attempts to restore the impacted areas, if, and when, BOCI begins to repair the damages. Progressive widening of seismic survey lines is also anticipated, a phenomenon documented by Duever (1985) following his extensive analysis of ORV impacts in the Preserve. Widening occurs when the trails become so rutted that vehicles cannot gain traction and must go around the difficult area, thereby creating new ruts which also eventually become impassable. Duever (1985) cites one example in the Preserve where a 0.25-mile wide corridor essentially devoid of vegetation has resulted from this widening phenomenon. Future, unauthorized ORV use of the seismic survey lines created by BOCI is also expected to result in an increased enforcement burden on the National Park Service, as it attempts to restrict access to seismic survey lines over the many years expected to pass before full restoration is complete.

4.2  Recommendations for Restoration, Maintenance and Monitoring

Based on our observations, it is clear that the magnitude and longevity of wetland impacts caused by BOCI’s Phase I seismic survey activities is far greater than what BOCI initially portrayed to the authorizing
agencies. Therefore, detailed planning for, and implementation of, restoration of impacts, mitigation for temporal losses of wetland function, development of defined restoration success criteria, long-term maintenance and monitoring methods to measure the efficacy of the restoration activities, and agency enforcement thereof, are critical. No additional seismic survey activities should be allowed to proceed given the nature and extent of the wetland damage caused by BOCI and the documented failures to comply with its state and federal permits. Recommendations for restoration activities are as follows:

1) BOCI must first locate and quantify all areas impacted to date by its activities. This essential first step should begin immediately, and should consist of BOCI’s submission of current aerial imagery of the Phase I seismic survey area to enable comparison of the impacts that occurred to pre-impact conditions, similar to the analysis performed by Quest using the most recent Google Earth imagery dated 5/27/17 (Figure 3). Impacts should also be quantified with respect to the various wetland communities and habitats affected, such as wet prairies and cypress strands, using aerial imagery in conjunction with ground-truthing.

2) Once the Phase I seismic survey impacts have been quantified, BOCI should quantify the loss of wetland function, beginning at the time of impact, and extending until all wetland functions are fully restored, for the purpose of determining an equivalent area of mitigation elsewhere in the Preserve, to offset the specific functional loss, and to restore an area providing wetland functional benefit equivalent to the wetland functional loss, as required by FONSI Minimization and Mitigation Measure No. 45 and Specific Condition 13(e) of the Geophysical Permit. Rule 62-345.600, Florida Administrative Code, provides the methodology for determining time lag and risk as part of the Uniform Mitigation Assessment Method (UMAM). Table 1 of this rule assigns a multiplier for wetland mitigation based on the amount of time necessary for a specific mitigation area and type to attain all wetland functions associated with the wetland habitat type being created, enhanced, or restored. In this situation, the multiplier would be assigned based on the habitat type impacted and restored. For example, for seismic survey lines that impacted dwarf cypress habitat being restored, the multiplier for a time lag of 55 years or more would be 3.91. Accordingly, the amount of mitigation conducted for temporal loss would be equivalent to the number of acres of dwarf cypress impacted, multiplied by 3.91. This assumes the same or similar level of functional gain from mitigation (after applying time lag and risk) as the risk-free functional gains from restoration of that particular habitat type. Restoration of impacts associated with preexisting ORV trails and/or oil pads within the Preserve or treatment of nuisance and exotic vegetation may serve as mitigation projects worthy of consideration and are preferable to the purchasing of mitigation bank credits, which was not contemplated by or analyzed by the National Park Service in the FONSI. Once the amount of mitigation has been determined using UMAM to increase or decrease amounts of lower-quality or higher-quality mitigation, respectively, a comprehensive mitigation plan should be developed that includes defined success criteria and long-term maintenance and monitoring criteria.

3) After all of the impacts have been identified, topographic restoration should begin immediately. All soils should be de-compacted and ruts levelled using hand tools. These areas should be returned to the topographic elevation that existed prior to the impacts and shall match the elevation of adjacent, undisturbed communities. Given the subtle topographic gradients of the Preserve and their dramatic effects on plant communities, restored elevations should be required to be within one (1) inch of adjacent, undisturbed elevations after one wet season has passed. Cypress tree stumps should be left in place so as not to further disturb soils. Other loose woody
debris should be removed from seismic survey lines (but not buried) and widely scattered around the seismic survey lines to minimize concentration of heavy fuel loads to try to minimize fire risk.

4) Supplemental planting of impacted areas should be conducted using only appropriate native wetland vegetation collected from similar habitats within the Preserve boundaries. Although cypress trees are generally available in commercial nurseries, the genetics of the dwarf cypress of the Big Cypress region are unique to extreme south Florida. Commercially-available cypress may compromise the genetic integrity of cypress indigenous to the Preserve, which may also experience high mortality rates due to the extreme hydrologic and soil conditions unique to the region.

   a) Cypress seeds should be collected from the Preserve, and contract grown before out-planting in the impacted cypress strands. Cypress cones typically mature between October and December (Duever, 1985), so seed collection should begin in the last quarter of 2018 to minimize further temporal wetland losses. Additional lag-time and functional losses will need to be accounted for while the cypress seedlings grow to a height capable of withstanding the hydrologic extremes (1-2 years). Cypress seedlings should be planted at a density of 600 trees per acre near the end of the wet season when standing water has receded, but adequate soil moisture remains to facilitate successful establishment. Seedlings should not be planted in straight lines, rather they should be staggered throughout the rutted areas to mimic natural distributions.

   b) Very few species of the diverse assemblage of groundcover plants are commercially available in the quantities that will be necessary to re-populate the acreage impacted. Furthermore, concerns regarding genetic pollution, the volume of plant material that would have to be brought into the Preserve and distributed along the many miles of seismic survey lines, and the expectation that non-native and/or weedy propagules would likely accompany containerized nursery stock, are all factors that favor local harvesting and transplanting of groundcover vegetation as the least impactful and most efficient method for restoring this stratum. It is recommended that 3 to 4-inch plugs be harvested from adjacent, undisturbed groundcover communities using post-hole diggers, and installed on 3-foot centers in all of the impacted areas that bisect wet prairie communities, including those cypress strands with a wet prairie groundcover understory. Plug harvesting should not be concentrated in one area. Rather, single plugs should be harvested from approximately 10-foot centers to enable quick recovery of the harvested areas. It is recommended that transplanting of the plugs occur near the end of the wet season, when standing water has receded, but adequate soil moisture remains to facilitate successful establishment.

4.2.1 Restoration Success Criteria Recommendations

The following restoration success criteria are recommended to ensure that BOCI’s restoration efforts will enable the affected communities to eventually return to pre-existing conditions:

   a) Elevations within impacted areas shall be restored to a final elevation that matches the elevations that existed prior to impact and matches the existing elevations in adjacent, undisturbed communities (+/- 1 inch).
b) Planted cypress trees shall maintain a density of 400 trees per acre or higher for a period of at least two years without supplemental planting.

c) Herbaceous obligate or facultative wet vegetation shall constitute 80% of the total vegetation coverage of the impacted areas and shall be rooted for at least 12 months, with no one species contributing more than 33% of the total vegetation coverage.

d) Non-native vegetation, as defined by the most current version of the USF Plant Atlas (Wunderlin et al, 2018), shall not exceed 1% of the total vegetation coverage.

4.2.2 Maintenance and Monitoring Recommendations

After the Phase I seismic survey impacts have been identified and quantified by habitat type, belt transects should be randomly established to capture approximately 1% of the area of each impacted habitat type. Each belt transect should be approximately 200 feet long and correspond to the shape and width of the impacted survey trail (approx. 12-15 feet). Planted tree density shall be calculated within this belt transect for trees greater than 18 inches tall. Groundcover monitoring should be conducted using 1 m² quadrats placed approximately every 50 feet along the belt transect (i.e., 4 quadrats), on alternating sides of the soil ruts. All vegetation rooted within the quadrat shall be identified and percent cover estimated. Percent cover of bare ground and open water within each quadrat shall also be estimated. Cover estimates for each species should be calculated for the belt transect as a whole, according to the following formula:

\[
\text{Total Cover of Species A} = \frac{\text{Combined % Cover of Species A}}{\text{Total # of Quadrats}}
\]

Water depths, if applicable, should also be measured in each quadrat, and soil saturation noted. Photographs should be taken from the beginning and end of each belt transect, and wildlife observations should be noted. A qualitative assessment of the success of the topographic restoration should be included. Semi-annual monitoring is recommended for a minimum of five years, or until the total vegetation coverage by obligate and facultative wetland vegetation achieves at least 80 percent of the total vegetation coverage based on the conditions that existed prior to seismic activities, and the total vegetation coverage by exotic and nuisance vegetation is less than 5% of the total vegetation coverage, whichever is longer.

During the five-year monitoring and maintenance period, BOCI should perform any necessary maintenance of the restoration areas, including but not limited to, replanting any planted vegetation that has not survived, and exotic and nuisance vegetation removal. There should be 0% of exotic and nuisance plant coverage in the restoration areas immediately after a maintenance activity, and exotic and nuisance plant coverage should not exceed 5% of the total vegetation coverage in the restoration areas between maintenance and monitoring events. Nuisance and invasive exotic vegetation shall be controlled by herbicide, fire, hydrological, or mechanical means in order to limit cover of nuisance species and to remove exotic species when present. Nuisance and invasive exotic species shall mean those species listed on the Florida Exotic Pest Plant Council’s most recent list of invasive plant species (http://www.fleppc.org/).

All tree, shrub and groundcover species should maintain an 80% survival rate for the duration of the maintenance and monitoring period. If survivorship in the seeded and planted areas falls below 80%, BOCI should conduct supplemental planting of the wetland vegetation. “Success of the restoration”
means that at the end of the monitoring schedule, the following success criteria has been continuously met for a period of at least two consecutive years, without intervention in the form of irrigation, herbicides, removal of undesirable vegetation, or replanting of desirable vegetation:

1. A minimum of 80% of the total vegetation coverage of desirable obligate and facultative wet vegetation in the restoration areas; and
2. The coverage of exotic and nuisance species in the restoration areas is 5% of the total vegetation coverage or less.

In the event the permitting agencies determine that the restoration areas are not meeting the above specified success criteria, BOCI should be required to submit an alternative restoration plan to the permitting agencies and restart the maintenance and monitoring period and continue until the permitting agencies determine that the success criteria have been achieved.

5.0 CONCLUSION

The Phase I seismic survey impacts documented in this report and Quest’s report dated August 2017, reveal that BOCI has violated multiple conditions of its state and federal permits, including FONSI Minimization and Mitigation Measures Nos. 1, 7, 18, 20, 21, and 22, FDEP Geophysical Permit Specific Condition Nos. 6, 9b, 10a, and 13, and FDEP Environmental Resource Permit Specific Condition Nos. 4, 6, 9, and 12, and General Condition No. 1.

BOCI underestimated the extent and nature of anticipated wetland impacts from its Phase I seismic survey activities. For example, impacts from 2017 seismic survey activities have proven not to be temporary, as deep ruts from 2017 are still present and vegetative cover was estimated at less than 5% along the seismic survey lines inspected. Furthermore, vegetation impacts are much more extreme than the anticipated vegetation “layover” effect portrayed in state and federal permit applications. In stark contrast, the Inspection Team observed extensive mortality of dwarf cypress trees, some expected to be hundreds of years old, as well as extensive mortality of wet prairie groundcover vegetation, consisting of a diverse assemblage of species that are not commercially available. Further, BOCI failed to restore soil ruts and vegetation damage as of 4/26/18.

BOCI must fully restore the damage it caused and demonstrate its ability to achieve defined restoration success criteria for affected wetland communities and habitats, and must mitigate for any temporal losses of wetland function. Further, the National Park Service should strongly consider prohibiting any additional seismic activities and undertaking supplemental environmental review of the effectiveness and adequacy of the FONSI Minimization and Mitigation Measures to prevent further damage in the Preserve.
Works Consulted


(Note: Link above also provides link to Google Earth .kmz file of trails in both Turn River and Corn Dance Unit, but also includes a few trails that cut thru Addition Lands.


Figure 1 - Location Map
Nobles Grade 3-D Seismic Survey (Burnett Oil Co., Inc.)
Natural Resources Defense Council
Big Cypress National Preserve, Florida
Figure 2 - Seismic Survey Impact Observations from 2018 Field Inspections
Nobles Grade 3-D Seismic Survey (Burnett Oil Co., Inc.)
Natural Resources Defense Council
Big Cypress National Preserve, Florida
Figure 3 - Approximate Seismic Survey Impact Observations from Google Earth (GE) Imagery

Nobles Grade 3-D Seismic Survey (Burnett Oil Co., Inc.)
Natural Resources Defense Council
Big Cypress National Preserve, Florida
This project location falls within the US Fish and Wildlife Services’ defined Florida panther habitat zone.

Legend
- Orange dot: Florida Panther Mortality
- Green dot: Florida Panther Telemetry
- Red line: Approx. Phase I Seismic Survey Boundary
- Blue line: Big Cypress National Preserve Boundary

Figure 4
Florida Panther Occurrence Records
Nobles Grade 3-D Seismic Survey
by Burnett Oil Co., Inc.
Big Cypress National Preserve, Florida
Photo 1: View south from Quest Photostation 8 on Seismic Survey Line A.

Photo 2: View west from Quest Photostation 8 on Seismic Survey Line A.

Photo Credit: Inspection Team, April 26, 2018
Photo 3: View south from Photostation 5 on Seismic Survey Line A.

Photo 4: View west from Photostation 5 on Seismic Survey Line A.

Photo Credit: Inspection Team, April 26, 2018
Photo 5: View north from Photostation 5 on Seismic Survey Line A.

Photo 6: View north from Photostation 10 on Seismic Survey Line A showing 3 receivers attached to wooden stakes.

Photo Credit: Inspection Team, April 26, 2018
Photo 7: View east from Photostation 10 on Seismic Survey Line A. This rut measured 17” deep on 6/15/17, and 11” deep on 4/26/18.

Photo 8: View west from Photostation 11 on Seismic Survey Line A with receiver in cypress tree on right side of trail.

Photo Credit: Inspection Team, April 26, 2018
Photo 9: View west of Photostation 12 at western terminus of Seismic Survey Line A.

Photo 10: View south of three UTV’s and a trailer with antenna parked at Photostation 9 on Seismic Survey Line A.

Photo Credit: Inspection Team, April 26, 2018
Appendix A
Seismic Survey Line A Photos

Photo Credit: Inspection Team, April 26, 2018
Photo 1: View east of Seismic Survey Line B from Photostation A.

Photo 2: View northeast of 5 vibroseis vehicles staged in a cypress strand wetland at Photostation B.

Photo Credit: Inspection Team, April 26, 2018
Photo 3: View northeast of 2 vibroseis vehicles staged in a cypress strand wetland at Photostation C.

Photo 4: View west of Seismic Survey Line B from Photostation D.

Photo Credit: Inspection Team, April 26, 2018
Photo 5: View east from Photostation E showing example of a seismic survey line greater than 15 feet wide at a location where vibroseis vehicles created two lanes of impact around an area of deep rutting.

Photo 6: View west from Photostation F showing deep ruts, cut dwarf cypress stumps from 2017 survey activities.

Photo Credit: Inspection Team, April 26, 2018
Appendix B
Seismic Survey Line B Photos

Photo 7: View of dwarf cypress stump measuring 40 inches (3.3 feet) in diameter at Photostation G. This specimen was removed from the survey trail, and is estimated > 330 years old.

Photo 8: View of dwarf cypress remains cut from the stump shown in Photo 7 (Photostation G) above. This tree was cut in 3 sections and cast south of the trail. When re-assembled, the trunk measured approximately 6.1 inches in diameter at breast height (dbh).

Photo Credit: Inspection Team, April 26, 2018
Photo 9: View west from Photostation H.

Photo 10: View west of more extreme rutting (~21 inches deep) observed ~100 feet west of Photostation H.

Photo Credit: Inspection Team, April 26, 2018
Photo 11: View west of fork in seismic trail at Photostation I.

Photo 12: View west from Photostation J.

Photo Credit: Inspection Team, April 26, 2018
Photo 13: View west from Photostation K.

Photo 14: View west from Photostation L. A dwarf cypress measuring 4.3 inches dbh and estimated to be 150-200 years old is visible at photo left.

Photo Credit: Inspection Team, April 26, 2018
Photo 15: View west from Photostation M.

Photo 16: View east from Photostation M.

Photo Credit: Inspection Team, April 26, 2018
Photo 17: View west from Photostation N.

Photo 18: View west from Photostation O.

Photo Credit: Inspection Team, April 26, 2018
**Photo 19:** Side view of one of three support vehicles with large tanks observed at Photostation D.

**Photo 20:** Rear view one of three support vehicles with large tanks observed at Photostation D.

*Photo Credit: Inspection Team, April 26, 2018*