1. Describe what progress you have made toward each of your grant objectives since your last status report. Did you meet your goals for this period? Please be specific.

**Objective A:** Use bathymetric and habitat data obtained from USFWS’s side-scan sonar project on the lower Niagara River to develop benthic habitat maps. Using the habitat maps, assess diversity and community structure of benthic macro-invertebrates (BMI) in the lower Niagara River.

**Objective B:** Document diet, habitat use and behavior (movements and migrations) of Lake Sturgeon in the lower Niagara River.

Progress has been made throughout 2016 and the goals for the period have been met. For a detailed description of how we met the goals and the work that has been done please see below.

To classify benthic habitats, two additional layers from the near-bottom flow and shear stress data were generated in ArcGIS. We also generated an updated bathymetry layer. The two layers were added to the substrate map (Figure 1).

To assess the diversity and community structure of benthos, we finished analyzing benthic samples from 15 historic sites that were first surveyed in 1983 and then re-surveyed by the Great Lakes Center in summer 2015. The results from this study were presented at an international conference in Guelph, Canada. Below are some of the major findings listed:

- the benthic community separates into three distinctive cluster: the upper river for both 1983 and 2015 and the lower river for both years
- the benthic communities in the lower river are more similar between 1983 and 2015 than in the upper river
- there is no significant change in species diversity between the historical and current sampling, however abundances in both the upper and lower river were significantly smaller in 2015 compared to 1983 (Figure 2)
- changes in benthic community in the upper and lower river between 1983 and 2015 were mainly caused by a dramatic increase of the low-tolerant caddisfly Brachycentrus sp. and the occurrence of Dreissena bugensis, respectively (Figure 3)
- Changes in species diversity in the upper river could be the result of improved water treatment and thus water quality
- Similarities in the species composition (esp. Oligochaeta worms) in the lower river could
be the result of a legacy of contaminates remaining in the sediment

- The introduction of exotic species after 1983 (*Echinogammarus ischnus*, *Dreissena* sp., and *Neogobius* sp.) may also affect the benthic community composition
- Information about residence time of toxins in sediments would greatly improve our understanding of the long-term effects on benthic communities in the Niagara River

Samples from bi-monthly sampling have been processed in the lab and are currently being analyzed statistically. We also started a Round Goby (*Neogobius melanostomus*) assessment survey in July 2016 and continued in December 2016 in the lower Niagara River using underwater videos at 50 sites along the lower river and the river mouth. This invasive benthic fish has become one of the main food items of the Lake Sturgeon. Information about the abundance of the Round Goby in the lower Niagara River would be valuable not only to better understand the feeding ecology of the Lake Sturgeon but also the impacts of the Round Goby on the entire ecosystem. Data from our underwater video survey also allows us to compare results from this study with other studies using different equipment. Preliminary results of goby counts in the river showed 150,000 individuals/ha.

**Lake Sturgeon Diet Documentation**
All stable isotope and stomach content sample collection was completed in 2015. In 2016, data analysis was finalized and work on preparing a manuscript for publication has nearly been completed. The paper will be submitted to a journal for review in early 2017. The paper presents the discovery that Lake Sturgeon primarily feed on benthic invasive species, such as amphipods and Round Goby (Figure 4 and 5). This finding is significant because Lake Sturgeon are not typically known to feed on live fish, but yet in the lower Niagara River, we have found that their most significant food source is Round Goby.
This has implications for the management of the Lake Sturgeon population as well as invasive species. It is possible that a robust population of Lake Sturgeon may aid in preventing the establishment of additional invasive species as well as put predation pressure on the existing invaders. This finding also bodes well for Lake Sturgeon recovery in the river. Invasive round goby and amphipods are found in very high numbers thus providing a plentiful prey base for Lake Sturgeon. It is evident that the Lake Sturgeon population is recovering through the consumption of invasive species.

**Habitat Use and Movement Documentation**
Data collection for this objective ended in March 2016. In total, we collected more than 10 million data points. Analysis of this large amount of data has been ongoing throughout 2016 and will continue into 2017. So far, we have identified residency patterns, stretches of the river that receive the most use, depth use over time, movements in relation to water temperature, home range size and daily activity levels (Fig. 6). These findings have yet to be finalized but are coming together as a manuscript.
We have found that the tagged Lake Sturgeon have very individual behaviors with no consistent population-level behaviors. Some fish stay in the river all year, some stay in out in the lake, and others still move between the lake and the river several times a year. We have found that activity levels and home range size increase in the early part of the year, indicative of spawning.
movements. This is also evident in their positions with respect to temperature-they tend to be further up in the river when temperatures are lower (Fig. 7). Management implications of this might include limiting disturbances in the Spring when their activity levels are higher. Also we must assume that there are Lake Sturgeon in the river at any point in the year as they do not enter or exit the river en masse.
2. How did you measure your progress since your last status report? What kind of data have been collected to determine whether progress is being made or not being made? What results have been obtained since your last status report?

Progress for objective A: We added two more environmental data layer and one updated bathymetry layer to the substrate map. We also completed 95% of all benthic samples that were collected from 2014 through 2015, presented at several conferences and workshops and published our results in the scientific journal *Hydrobiologia*.

Fig. 1. Updated bathymetry layer (left) and near-bottom shear stress layer in the lower Niagara River.
**Fig. 2.** Total number of organisms in the lower Niagara River (left) and upper Niagara River (right) in 1983 and 2015.

**Fig. 3.** Taxa composition in the lower Niagara River (left) and upper Niagara River in 1983 and 2015.
Progress for objective B is measured by the completion of data analysis and submission of manuscripts for publication. We have completed most of the data analysis and will be looking to publish the findings in 2017.

**Fig. 4.** Percent frequency of occurrence, weight, and count of prey items found in the stomachs of 56 Lake Sturgeon captured from the lower Niagara River.
Fig. 5. Mean values and 95% confidence intervals of $\delta^{15}$N and $\delta^{13}$C (‰) in Lake Sturgeon fin, red blood cell (RBC), plasma tissue, and prey sources. Values are not adjusted for trophic shift.
Fig. 6. Mean ± SEM home range size of tagged Lake Sturgeon through the years of the study. Home range is defined as the difference between the most upstream and downstream locations for each month.
Fig. 7. Mean daily river position of tagged Lake Sturgeon in relation to water temperature. The horizontal line represents the position of the mouth of the lower Niagara River.
We also presented our results at several international and local meetings:


Journal Publication:

3. What challenges have you encountered since your last status report? How are you addressing these challenges?

A problem we still encountering is the difficulty to obtain sediment samples with a PONAR grab in areas of bedrock and gravely substrate and thus we were only able to obtain a sample at 150 out of 200 (75%) sampling sites. The southernmost part of the lower Niagara River lacks data due to the strong currents near the gorge that prevented safe and successful sampling. We tested the efficiency of indirect sampling methods such as underwater videos to assess the benthic community from these substrates. It worked out well for larger organisms, such as *Dreissena* sp. (please see publication in the scientific journal *Hydrobiologia*).

The analysis of the acoustic telemetry data has been a challenge. This area of science is constantly evolving with new analyses and techniques and it has been a challenge to learn and apply these methods to our data. Our dataset is also very large making the process even more complex and time-consuming. Each telemetry study has its own unique challenges of which we are working through.
4. Are you on schedule to complete your project in the proposed timeline? If not, please explain why you are ahead or behind schedule.

Based on the progress we have made up to this point we are certain that the project will be completed within the proposed timeline. However, we decided to extend our timeline to December 2017 as we decided to add a Round Goby survey to our study. Round Goby’s not only prey on benthic invertebrates and fish eggs they have also become one of the most important prey items of the Lake Sturgeon. Therefore, information on the density and biomass of this species would add increase our knowledge on how much food resources are available for higher trophic levels.
5. Please use the table below to report your expenditures since your last status report. Include in-kind support from other resources you have used since your last report below the table. Please explain any differences between anticipated and actual expenditures. Attach copies of any relevant receipts or invoices to this report.

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6. What progress toward your objectives do you expect to make before your next status report? Please be specific.

Before the next status report we plan to:

1. Complete statistical analysis of results from the bi-monthly survey and prepare manuscripts for publication.

2. Continue Round Goby survey throughout next year and add results to our benthic habitat maps and species distribution models.

3. Complete the diet characterization and movements/habitat use, prepare manuscripts and submit them for publication.
4. Please include 1 to 2 photographs with dates and short descriptions taken since your last project report.

Photo 1: Lake Sturgeon in the lower Niagara River (Eric Bruestle, 2016)
Greenway Ecological Standing Committee
Grantee’s Status Report

Photo 2: Eric and Kurt measuring a Lake Sturgeon (Dimitry Gorsky, 2016)