

2020 Apple Hill Solar Rare Plant Monitoring Report

I. Introduction

The Apple Hill Solar Project (Project) is a proposed 2.0 MW solar electric generation facility at 1133 Willow Road in Bennington, Vermont. An application for a Certificate of Public Good was submitted in 2014. Arrowwood Environmental (AE) conducted an environmental review for the Project in 2014 and submitted a report documenting the findings of that review (AE, 2014). At that time, multiple species of uncommon and rare plant species were documented on the site, including arrow-leaved aster (*Symphyotrichum urophyllum*) and nimblewill muhly (*Muhlenbergia schreberii*). Project redesign resulted in the avoidance of many of the uncommon and rare plant occurrences. As part of the application process the Project obtained a Memorandum of Understanding (MOU) with the Vermont Agency of Natural Resources (ANR) which outlined mitigation measures to protect rare species on the site. These measures included the establishment of a Conservation Area, the transplantation of rare plants, avoidance protocol and a requirement to monitor the transplanted plants.

The purpose of this report is to present the data on the transplantation monitoring efforts that occurred in 2020. The report is divided into two sections, the first addressing the nimblewill muhly populations and the second addressing the arrow-leaved aster populations.

II. Nimblewill Muhly

Four populations of nimblewill muhly were documented on the Project site and are shown in Figure 1. Site A consists of an old logging road with hundreds of plants scattered in loose mats along the road. Site B is also an old logging road which widens near the northern end. This area contains dense mats of nimblewill muhly likely containing many hundreds of plants. Both of these populations occur in mixed sun and shade conditions growing in slightly compacted soil. The plants appear to be vigorous and in good

health with many showing signs of reproduction. As mentioned in previous reports, only a subset of plants from these locations have been transplanted into the Conservation Area.

Site C consisted of 29 stems in two separate clumps (genets) in the shade beneath a canopy of buckthorn and northern hardwoods; all 29 stems were previously transplanted into the Conservation Area. Site D consists of a woods-edge in partial sun and contains two clumps with 30 stems. As outlined in the MOU, Population D was not transplanted. The boundaries of the population, however, have been staked and flagged with high visibility flagging.

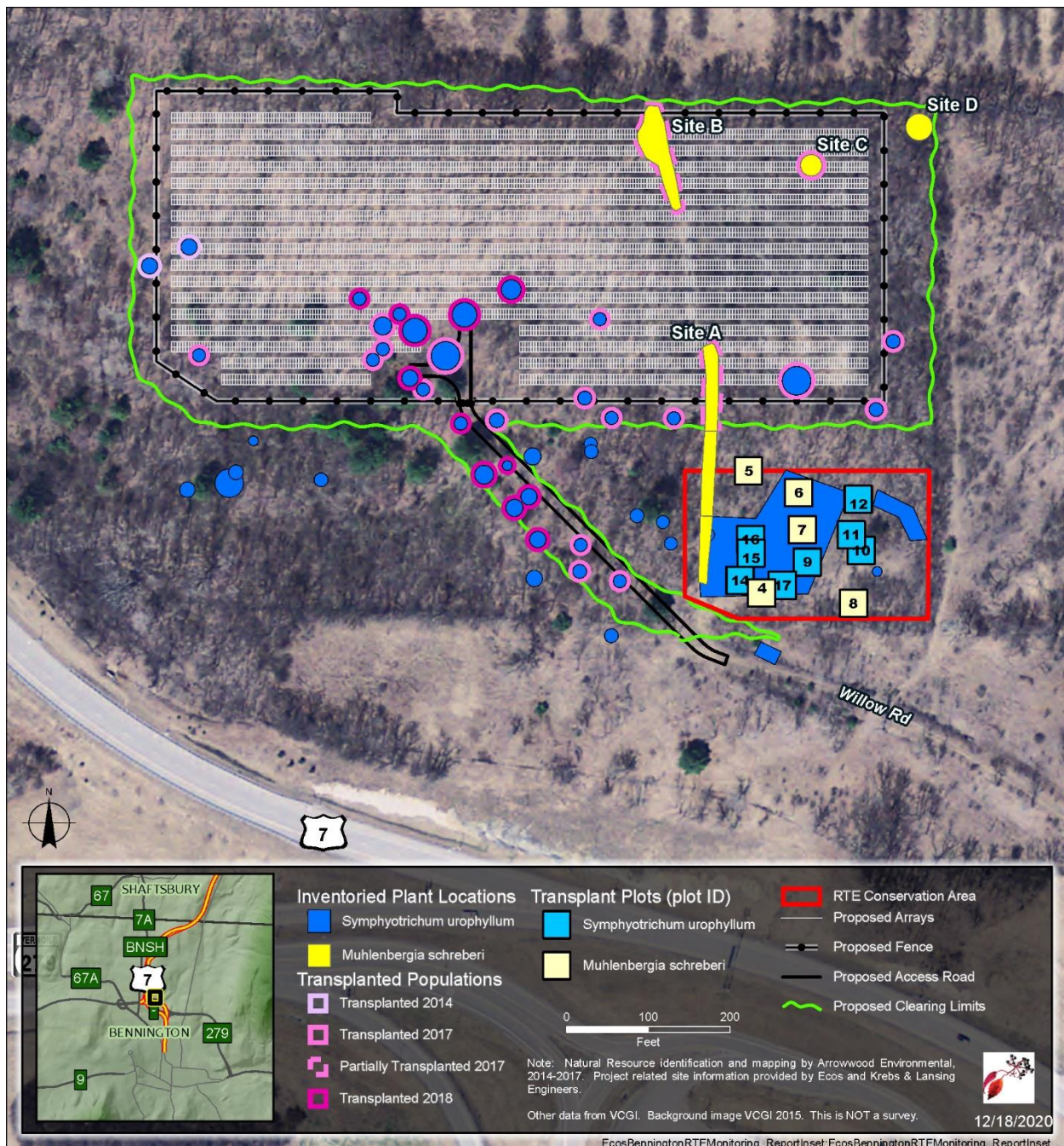


Figure 1. Map of rare plant populations and transplant plots

Monitoring of the nimblewill muhly transplant plots has occurred once per year since transplantation in 2014. Monitoring consists of documenting the percent cover of nimblewill muhly plants as well as notes on the health, vigor and evidence of reproduction. Weeding of the monitoring plots has occurred yearly since 2017. Appendix 2 consists of a photo log of the transplant plots.

Table 1 summarizes the nimblewill muhly transplant data. Since stem counts of this species are difficult, the main metric used for determining success of the transplants is percent cover.

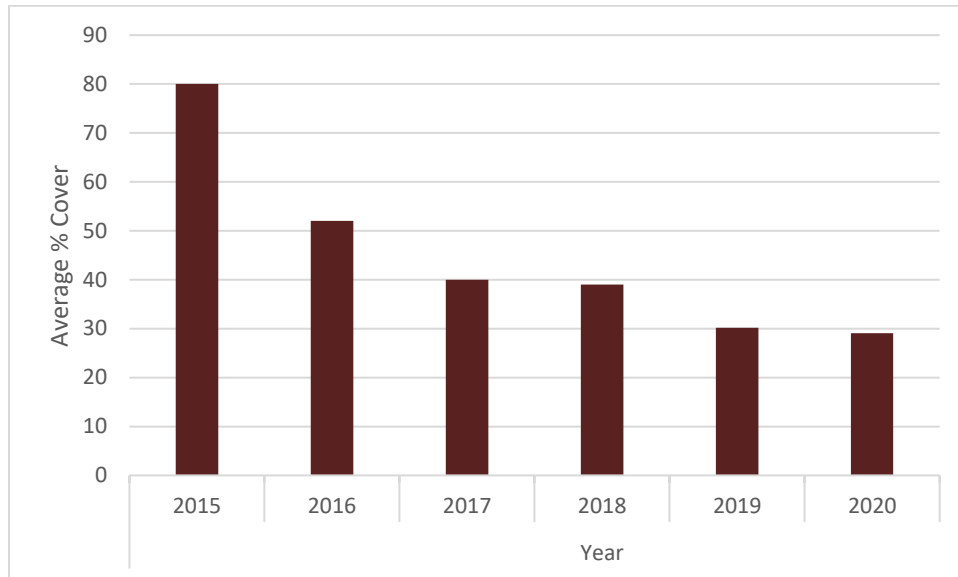
Table 1. Summary of transplant data for nimblewill muhly

Plot#	2015 % Cover	2016 % Cover	2017 % Cover	2018 % Cover	2019 % Cover	2020 % Cover	Change from 2015
4	75%	50%	80%	85%	75%	70%	-5%
5	85%	65%	70%	60%	30%	40%	-45%
6	90%	50%	25%	25%	35%	25%	-65%
7	70%	30%	15%	15%	6%	10%	-60%
8	80%	65%	10%	10%	5%	0.5%	-79.5%

As can be seen from Table 1, in most cases percent cover of nimblewill muhly plants has dropped substantially since transplantation. The percent cover of nimblewill muhly plants in Plot 4, however shows a different trend. In this plot, the percent cover has fluctuated through the years, but is now very near the cover value at transplantation. This is also the plot that receives the most direct sunlight, though it is unknown if this is the cause of the higher plant cover. All of the plants were transplanted from an area that was densely shaded, so access to sunlight is not expected to be a limiting factor in the survival of this species at this site.

The trends in percent cover since transplantation across plots are shown in Figure 2, which illustrates the average percent cover of the transplanted nimblewill muhly by year. This chart shows a significant drop in cover from 2016 to 2015, presumably due to transplant shock. Since 2016 there has been a steady decline in percent cover. However, the cover of nimblewill muhly in 2020 is not statistically different than the cover recorded in 2019 (paired Student's T-test $p=0.387$). Additional years of monitoring data will clarify whether the decline in cover has plateaued and whether cover of nimblewill muhly will rebound in the Conservation Area.

Figure 2. Average percent cover of nimblewill muhly in transplant plots



Transplant plots will continue to be monitored for a period of three years post-construction to comply with the MOU.

III. Arrow-leaved Aster

Rare plant inventories of the site occurred in 2014 and 2017. Transplantation of arrow-leaved aster occurred in 2014, 2017 and 2018 as shown in Figure 1. The plants transplanted in 2014 were transplanted to the Conservation Area in the Chelsea Hill Solar facility. Data on the survivorship of those plants is presented in the yearly monitoring report for that project.

Table 2 shows the number of plants present in the arrow-leaved aster transplant plots for Apple Hill Solar.

Germination of the arrow-leaved aster seeds appears to be good within the transplant plots. There is often a flush of recently germinated plants which survive for a single season and then die. Since these recently germinated basal rosettes look very different from the mature plants, this was not recognized until 2019. In 2019 the number of these basal rosettes was counted and the numbers of these are presented in Table 2. Since the majority of these plants will die, it is unlikely that these numbers will represent a spike in the population. However, this information may be useful in understanding the local population dynamics in future years.

As can be seen from Table 2 survivorship of the arrow-leaved aster plants has been relatively successful. With the exception of Plot 9, all plots have shown an overall increase in number of plants since transplantation. In some cases (Plots 14, 15, and 17) the number of plants present has more than doubled since transplantation.

Table 2. Summary of transplant data for arrow-leaved aster

Year Established	Plot	# Plants in 2017	# Plants in 2018	# Plants in 2019 ¹	# Plants in 2020 ¹	Change since transplantation
2017	9	32	30	18 (8)	17 (6)	-15
	10	45	44	69 (16)	68 (22)	+23
	11	32	26	37 (10)	44 (19)	+12
	12	21	20	30 (21)	25 (30)	+4
2018 ²	14	NA	15	53 (0)	40 (15)	+21
	15	NA	19	39 (23)	42 (69)	+23
	16	NA	18	24 (13)	26 (42)	+8
	17	NA	20	40 (23)	61 (57)	+41

¹ Number of recently germinated (1st year) basal rosettes shown in parenthesis

² Plot #13 is present in the Chelsea Hill Project Area

The trends in number of arrow-leaved aster plants across plots are also shown in Figure 3, which illustrates the average number of plants in the transplant plots by year. From this figure, a decrease in average number of plants is seen in 2018. This, however, is a reflection of the transplantation effort that occurred during that year. In 2018, plots 14-17 were established with 18-20 plants in each plot, whereas plots 9-12 had 20-44 plants in each plot in 2017. The decrease evident in Figure 3 is therefore not due to decreased survivorship of the transplants, but due to the establishment of plots 14-17 with lower number of transplants.

Figure 3. Average number of arrow-leaved aster plants in transplant plots

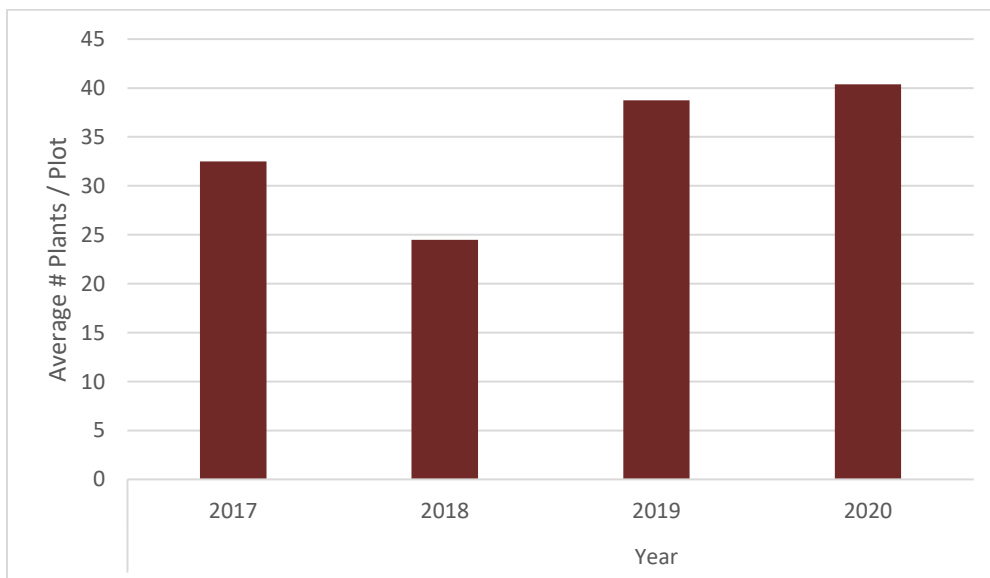


Figure 3 also illustrates that the average number of plants in the transplant plots has been increasing since 2018. The increase from 2019 to 2020, however is slight and not statistically significant (paired Student's

T-test $p=0.327$). Further monitoring in 2021 will determine if the increasing trend continues or if the populations are reaching a plateau. In either case, it appears that the transplantation effort of arrow-leaved aster at this site has been successful so far. The transplant plots will continue to be monitored once per year for a period of three years post-construction to comply with the MOU.

Appendix 1:

Nimblewill Muhly
Transplant Plot Photo Log

Plot 4



T4 Nimblewill Muhly Transplant Plot 10/7/15



T4 Nimblewill Muhly Transplant Plot 9/13/16



T4 Nimblewill Muhly Transplant Plot 9/7/17



T4 Nimblewill Muhly Transplant Plot 10/17/18

Plot 4 (con't)



T4 Nimblewill Muhly Transplant Plot 9/27/19



T4 Nimblewill Muhly Transplant Plot 10/1/20

Plot 5



T5 Nimblewill Muhly Transplant Plot 10/7/15



T5 Nimblewill Muhly Transplant Plot 9/13/16



T5 Nimblewill Muhly Transplant Plot 9/7/17



T5 Nimblewill Muhly Transplant Plot 10/17/18

Plot 5 (con't)



T5 Nimblewill Muhly Transplant Plot 9/27/19



T5 Nimblewill Muhly Transplant Plot 10/1/20

Plot 6



T6 Nimblewill Muhly Transplant Plot 9/13/16



T6 Nimblewill Muhly Transplant Plot 9/7/17 Looking North



T6 Nimblewill Muhly Transplant Plot 10/18/18



T6 Nimblewill Muhly Transplant Plot 9/27/19

Plot 6 (con't)



T6 Nimblewill Muhly Transplant Plot 10/1/20

Plot 7



T7 Nimblewill Muhly Transplant Plot 10/7/15



T7 Nimblewill Muhly Transplant Plot 9/13/16



T7 Nimblewill Muhly Transplant Plot 9/7/17



T7 Nimblewill Muhly Transplant Plot 10/18/18

Plot 7 (con't)



T7 Nimblewill Muhly Transplant Plot 9/27/19



T7 Nimblewill Muhly Transplant Plot 10/1/20

Plot 8



T8 Nimblewill Muhly Transplant Plot 10/7/15



T8 Nimblewill Muhly Transplant Plot 9/13/16



T8 Nimblewill Muhly Transplant Plot 9/7/17



T8 Nimblewill Muhly Transplant Plot 10/18/18

Plot 8 (con't)



T8 Nimblewill Muhly Transplant Plot 9/27/19



T8 Nimblewill Muhly Transplant Plot 10/1/20

Appendix 2:

Arrow-leaved Aster Transplant Plot Photo Log

Plot 9



T9 Arrow-leaved Aster Transplant Plot 11/28/17



T9 Arrow-leaved Aster Transplant Plot 9/27/19



T9 Arrow-leaved Aster Transplant Plot 10/1/20

Plot 10



T10 Arrow-leaved Aster Transplant Plot 11/28/17



T10 Arrow-leaved Aster Transplant Plot 9/27/19



T10 Arrow-leaved Aster Transplant Plot 10/1/20

Plot 11



T11 Arrow-leaved Aster Transplant Plot 11/28/17



T11 Arrow-leaved Aster Transplant Plot 9/27/19



T11 Arrow-leaved Aster Transplant Plot 10/1/20

Plot 12



T12 Arrow-leaved Aster Transplant Plot 11/28/17



T12 Arrow-leaved Aster Transplant Plot 9/27/19



T12 Arrow-leaved Aster Transplant Plot 10/1/20

Plot 14



T14 Arrow-leaved Aster Transplant Plot 9/27/18



T14 Arrow-leaved Aster Transplant Plot 9/27/19



T14 Arrow-leaved Aster Transplant Plot 10/1/20

Plot 15



T15 Arrow-leaved Aster Transplant Plot 9/27/18



T15 Arrow-leaved Aster Transplant Plot 9/27/19



T15 Arrow-leaved Aster Transplant Plot 10/1/20

Plot 16



T16 Arrow-leaved Aster Transplant Plot 9/27/18



T16 Arrow-leaved Aster Transplant Plot 9/27/19



T16 Arrow-leaved Aster Transplant Plot 10/1/20

Plot 17



T17 Arrow-leaved Aster Transplant Plot 9/27/18



T17 Arrow-leaved Aster Transplant Plot 9/27/19



T17 Arrow-leaved Aster Transplant Plot 10/1/20