Impact of invasive EWM in LCI 2013 to 2018 19 January 2019 ras ed3

Notes on ES report and weed densities 17 Jan 2019 *Website title: Rise and Fall of Invasive Eurasian milfoil in LCI:2013-2018.*

Impact of invasive Eurasian watermilfoil at monoculture density on other aquatic community plants in two Les Cheneaux Islands bays.

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Abstract.

An unprecedented dense growth of the highly invasive Eurasian watermilfoil *(Myriophyllum spicatum)* reached monoculture levels in Cedarville and Sheppard bays within the Les Cheneaux Islands (LCI) in 2011 and 2012. Dense patches of Eurasian watermilfoil (EWM) grew in over ten percent of other LCI waters during that time. The objective of this six-year study was to learn how EWM and other rooted aquatic plants (macrophytes) responded to the record EWM density of that period. Beginning in 2013, EWM density fell precipitously in both bays and remained at low levels for the remainder of the study. Based upon point-intercept analysis, growth density of other macrophytes common to these bays decreased, remained constant, or increased during the study period. Possible explanations for the dramatic EWM decline include: natural EWM life cycle, natural pathogens, allelopathic agents, water level/temperature, or a combination of these.

Background.

EWM was first observed in Cedarville Bay (CBay) by the DNR in 2003 (1). Dense EWM growth to monoculture levels was recorded in CBay from 2005-2007 and declined in density from 2008 through 2010 until rapid, aggressive growth resumed in 2011-2012. During the recent study period from 2013 through 2018 no significant efforts to control EWM were undertaken. Small efforts to manage EWM growth at waterfront properties such as raking, cutting and use of benthic tarps were employed by some.
In addition, two experiments encompassing a total of one-half acre were conducted using an experimental fungus. One study was conducted in CBay and a second study was conducted in Sheppard Bay (SBay). Since the total area of these bays is about 250 acres and 300 acres, respectively, it is not considered the small acreage studies had any obvious effect on EWM populations during the 6 yr study reported herein.

Methods.

Point-Intercept Survey Method (2). A grid of evenly spaced coordinates was generated based on GPS. LCWC and EnviroScience surveyors navigated from point to point along grid lines. At each GPS-identified point a rake was tossed into the lake and plants recovered from the retrieved rake were identified and assigned a density value. It was these findings that were used to generate maps depicted in Fig. 1. (3).

Methods cont'd

Rooted aquatic plants (macrophytes) recovered from CBay and SBay are listed below. Recall that, although stalked, Chara is an alga.

Common Name	**Latin nomenclature**
Nitella	*Nitella* sp (Stonewart)
Coontail	*Ceratophyllum demersum*
Elodea	*Elodea canadensis*
Eurasian watermilfoil	*Myriophyllum spicatum*
Illinois pondweed (pw)	*Potamogeton illinoensis*
Clasping-leaf pw	*P. richardsonii*
Variable pw	*P. gramineus*
Flatstem pw	*P. zosteriformis*
Large-leaf pw	*P. amplifolius*
Robbins / Fern pw	*P. robbinsii*
Naiad / Bushy pw	*Najas flexilis*
Eel grass	*Vallisneria americana* (Water celery)
Chara	*Chara* spp (Muskgrass)

Results and Discussion:

Maps generated by EnviroScience (ES) provide a visual assessment of the rapid decline of Eurasian watermilfoil in Cedarville (CBay) and Sheppard Bay (SBay): Fig. 1. The number of colored dots decreased each year in both bays as seen by fewer colored dots from 2013 through 2018. The ES maps can be interpreted by color and number of dots representing sample points as well as the number and density of species recovered by each rake toss.

Decreased EWM density is graphically shown for each bay in Fig. 2. The decline of EWM in CBay continued through 2016 at which point the frequency of EWM recovery remained about constant through 2018. EWM declined more rapidly in SBay and was lowest in 2015, a year earlier than the low point observed for CBay. SBay EWM levels also remained relatively flat through 2018.

Causes for the rapid decline in EWM populations are unknown at present. The Lake Huron water level increase of about 24 inches by 2015-2016 and of about 48 inches by 2018 , or simply fluctuations in water temperatures may have influenced the EWM decline. It is more likely that natural pathogens contributed to EWM decline following the years of intense EWM growth. During times of prolonged, intense growth of any given organism it is common for populations of organisms pathogenic to that species to increase in density as well. In this case of prolonged, intense EWM growth it is likely that pathogenic organisms such as fungi, bacteria or virus', or a combination of all, could have infected the EWM and contributed to the observed decline. CBay and SBay experienced aggressive, dense EWM growth for multiple, successive years, thus creating favorable conditions for buildup of organisms pathogenic to EWM itself.

Finally, we might have witnessed a natural succession in aquatic plant dynamics during the past six years. It could be that, just as succession patterns occur for forests and for prairies, our study could have documented aquatic plant succession dynamics that are a normal but unidentified occurrence.

Another possibility for the rapid EWM decline in CBay and SBay could be increased concentrations of allelochemicals. Allelochemicals are secondary metabolites not required for growth or metabolism which contribute to plant defense against competitor plant species. Note that three other macrophytes: Naiad, Eel grass and Chara, were present at densities similar to EWM in 2013. It could have been that one or more of these macrophytes synthesized and emitted allelochemicals toxic to EWM which contributed to the recorded EWM decrease. Another possibility is the production of allelochemicals by EWM itself. That is, there could have been conditions whereby inhibitory compounds produced by EWM became highly concentrated due to heavy growth which resulted in the EWM itself being inhibited and, thus, a decline in density ensued. Such a scenario could be the effect of a natural biochemical feedback mechanism for overall, long-term protection of the EWM population.

Another cause for the EWM decline could have simply been part of its life cycle with or without one or more of the above possible contributors. Smith and Barko (4) reported that EWM populations cycle about every 8 to 15 years once a stable population has been established. It is unknown if EWM will continue to slowly increase density among other macrophytes in CBay and SBay or if competition from other plants will inhibit a resurgence of EWM in these two bays.

Not all macrophytes declined in density during this period. Fig. 3 shows the decline of EWM but also shows the density of Variable pondweed (pw) for the same time frame. In CBay Variable pw was at a constant density from 2013 through 2015, experienced a growth spurt in 2016 with a dip in 2017 and another rise in 2018. Variable pw growth was similar in SBay, except it was at the same density from 2013 through 2016, experienced a dip in 2017 and a spike in growth in 2018. Observation of the Variable pw growth indicates that whatever affected EWM density in these two embayments did not affect the Variable pw in the same manner. Perhaps Variable pw was able to better compete with lower EWM density.

Figures 4A and 4B show growth of all major macrophytes and their relative growth densities in CBay and SBay through the 2013-2018 study period. Note that, although a stalked plant, Chara is actually an alga. In Fig. 4A one can follow the growth density, as measured using the point-intercept method, for all major species recovered by rake collection. In the case of EWM, one sees decreasing density from 2013 through 2018 as indicated by shorter bar length of the growth continuum. Also instructive in Fig. 4A is that Naiad, Eel grass and Chara far exceed EWM in annual and overall density during the study. Finally, one species that experienced a population increase in 2018 was Variable pw. It is not known at this time if Variable pw will continue to grow at the rate observed for 2018 vs the previous five years of less growth.

A similar picture for overall species presence is seen for SBay in Fig. 4B, in that EWM density declined sharply by 2015 and the most densely present species observed during the study were the same as observed for CBay: Chara, Eel grass and Naiad. Another similarity with Fig. 4A is the growth spurt of Variable pw in 2018. Clasping-leaf pw also exhibited a population increase in 2018 vs 2017 as was observed in CBay, but to a lesser degree than was observed for Variable pw.

Aside from the almost monoculture growth of EWM in CBay and SBay in 2013, Figs. 4A and 4B indicate that this species has been observed to be just another plant present in the macrophyte communities of CBay and SBay during remaining years of the study.

Fig. 5 shows the relative growth density of six species that were present during all sampling events of the study. During intermediate years CBay EWM density was lowest in 2016 and SBay EWM density was lowest in 2015. Figures 5A-5C and 5D-5F show densities of EWM in relation to other macrophytes present. As with Figs. 4A and 4B, the Fig. 5 charts demonstrate that other major macrophytes are similar in both bays and that those species compete quite well in the presence of EWM and may possibly help restrict EWM growth during the times of higher lake levels.

To expand on the differing growth of six species that were present in both bays during this study, Figs 6A and 6B show fluctuations for each species from 2013 through 2018. EWM and Elodea are seen to decline and remain at a lower density in Fig. 6A. Variable pw grew at a steady rate and spiked in 2018 in both bays. Robbins pw declined by mid-study but rebounded towards the end. Naiad peaked in both bays in 2015, dropped off somewhat in CBay by 2018 but increased in SBay. Eel grass was fairly constant in density throughout the study in both bays. Naiad and Variable pw appear to have increased in density in 2018 relative to other plants.

Summary:

Intense EWM growth occurred in two LCI bays during 2011-2012, then began decreasing rapidly in 2013 and remained at a low population level through 2018. Other macrophytes in both bays continued to grow with minimum year-to-year change and some species increased in density during the six-year study. Dynamics of EWM growth during the study have been postulated but not proven.

Literature Cited:

1. E. Bacon. 2003. Eurasian watermilfoil population in Cedarville Bay. MI DNR, Pers. Comm.

2. Madsen, J. 1999. Point intercept and Line intercept methods for aquatic plant management. Aquatic Plant Control Technical Note. MI-02.

3. Marquette, C. 2018. Vegetation, Weevil population and Microplastic surveys conducted in the Les Cheneaux Islands:2018. EnviroScience, Inc.

4. Smith, C.S. and J.W Barko. 1990. Ecology of Eurasian watermilfoil. J. Aquat, Plant Manage. 28:55-64.

Fig. 1. EWM density change in Cedarville Bay and in Sheppard Bay from 2013 through 2018 based on point-intercept surveys conducted by ES and LCWC.

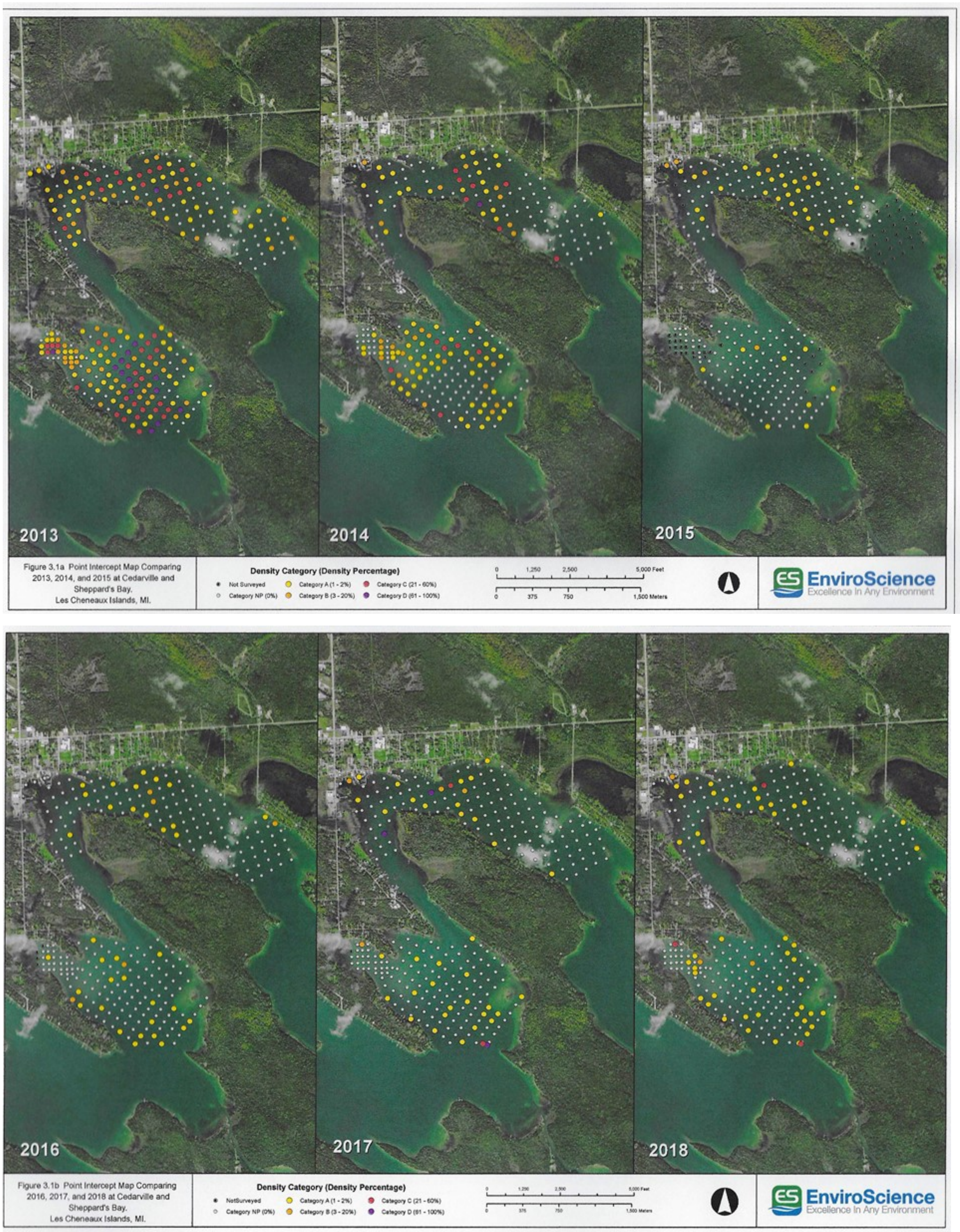


Fig 2. Eurasian watermilfoil presence in Cedarville and Sheppard Bays during 6 yr period. Values determined from % total observations (n=avg of 145) using point-intercept survey each year. <ESI FINDINGS 2013 - 2018 SHT 4 AA25> SHT5 D10

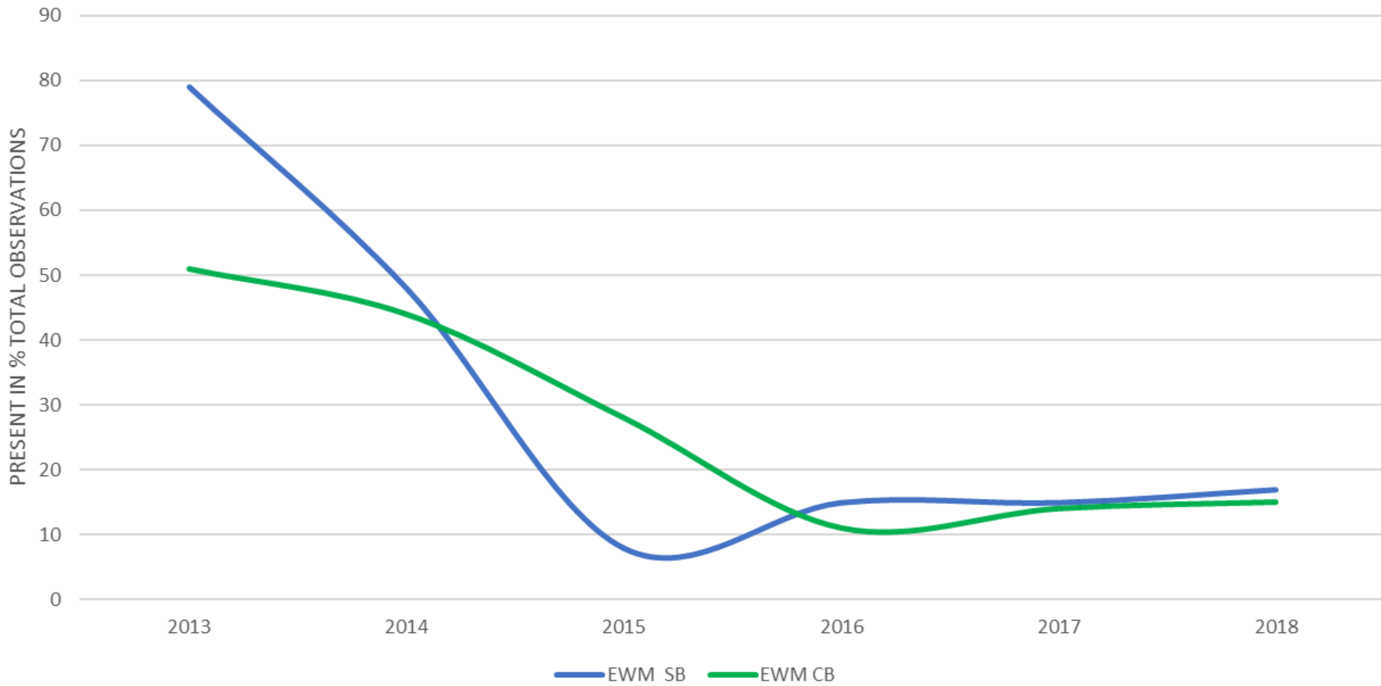


Fig. 3. Presence of Eurasian watermilfoil (EWM) & Variable pondweed in CBay & SBay
sht3 k35 <sht 5 D33>

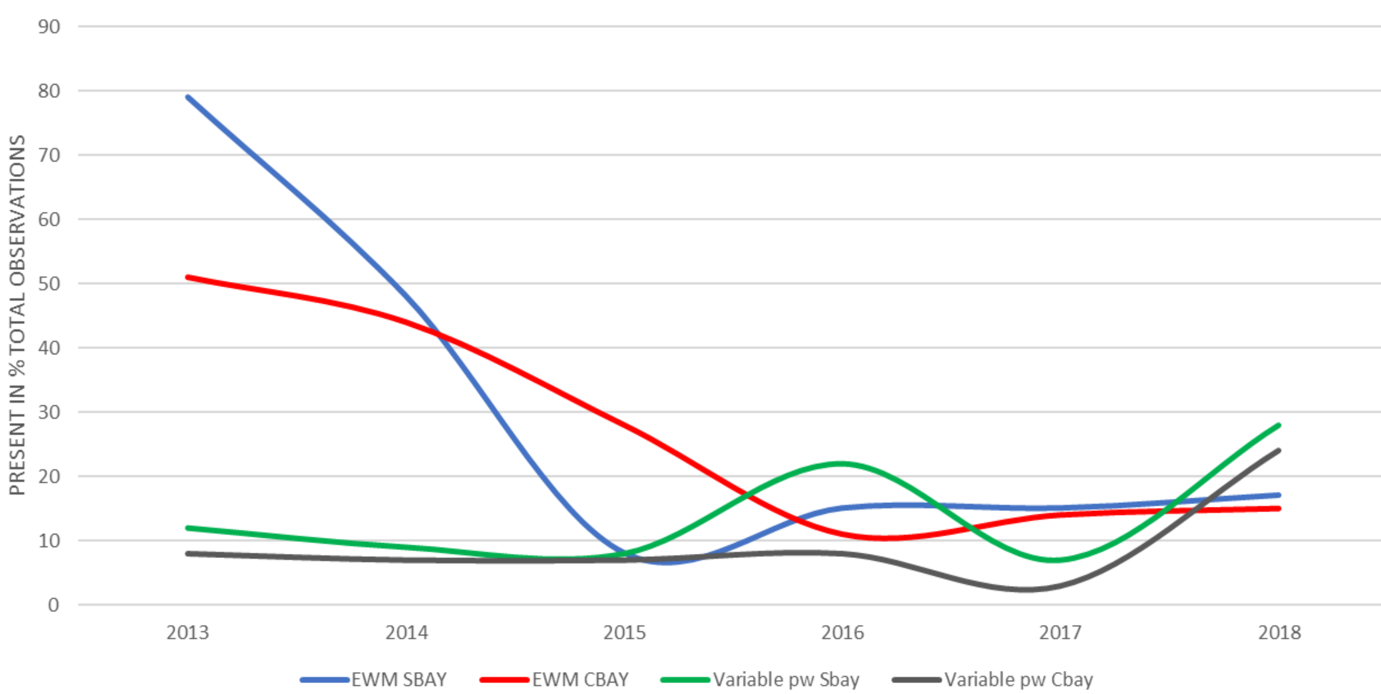


Fig. 4 A. Relative presence of major aquatic weeds inCBay during six yrs

<ESI FINDINGS 2013 2018 SHT2 x33>< sht5 d60>

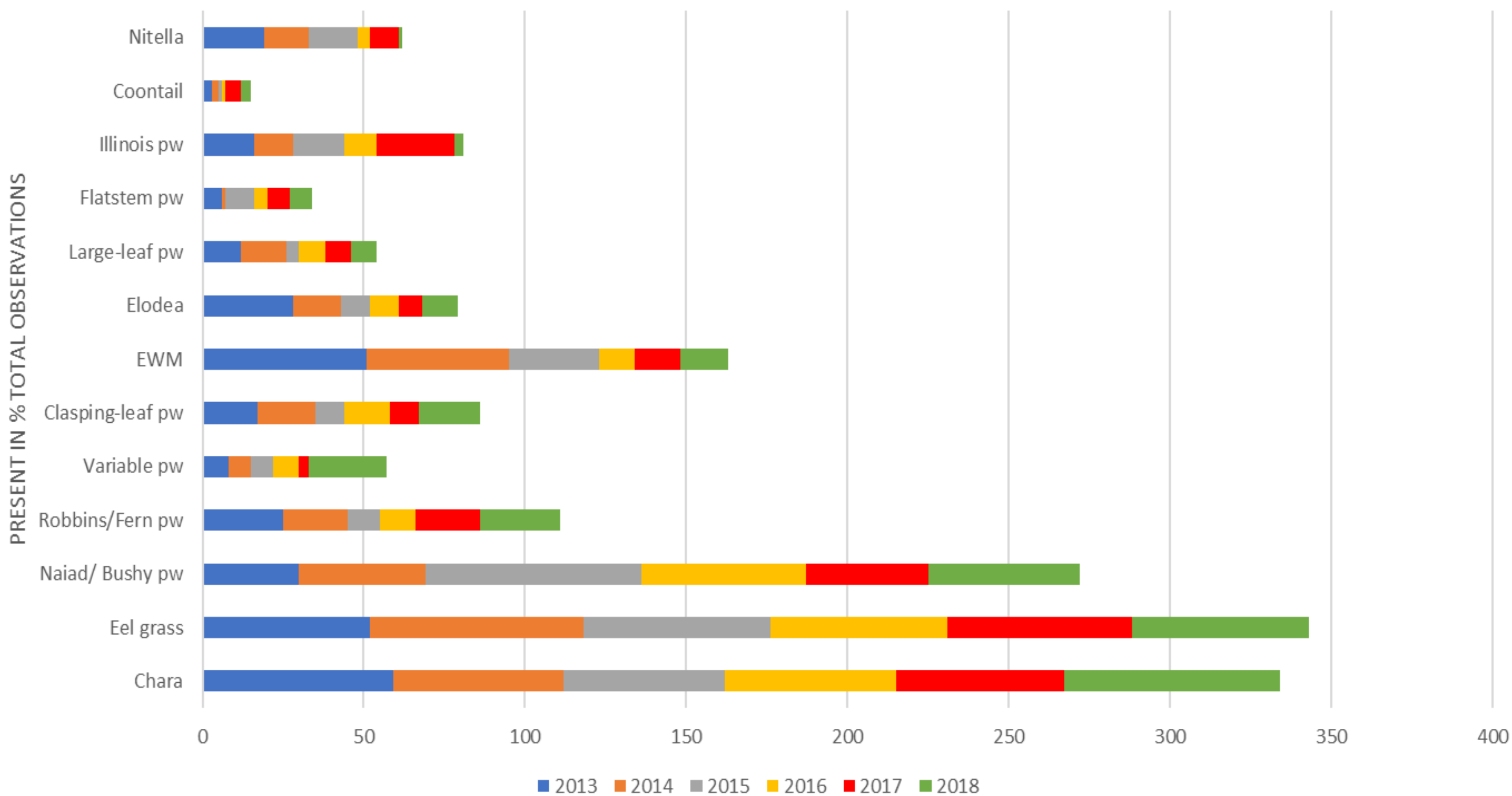


Fig. 4B. Relative presence of major aquatic weeds in Sheppard Bay during a 6 yr period. <ESI FINDINGS 2013 2018 SHT 4 AN25><sht5 d88

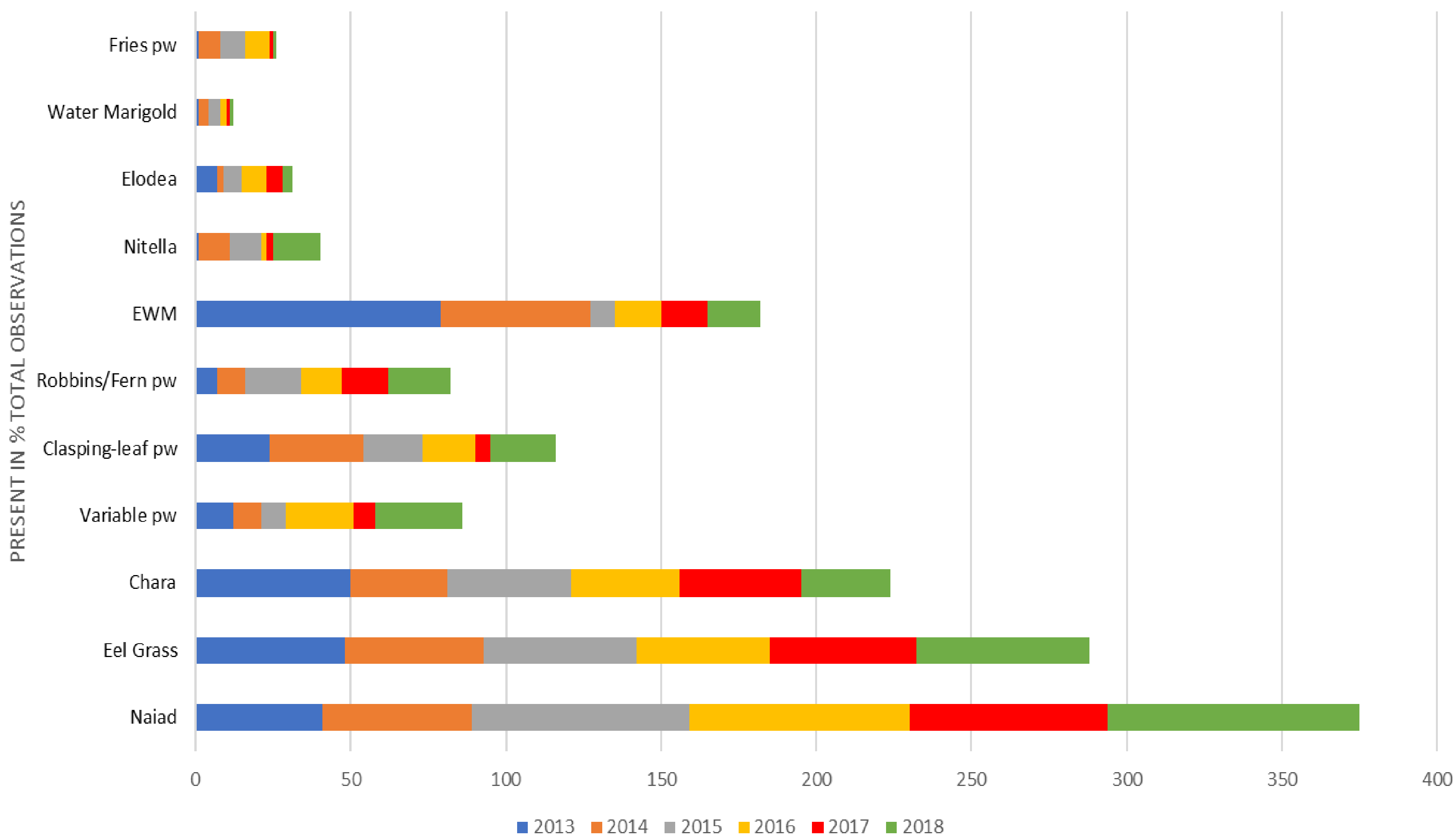


Fig 5 A-F. Charts showing relative plant densities of selected macrophytes from 2013 through 2018 in Cedarville and Sheppard Bays. EWM was lowest density in CBay in 2016 and lowest density in SBay in 2015 which are depicted in Figs 5B and 5E, respectively. <Sht5 D120>

Fig 5A. 2013 CBay densities sht2 bg100 / sht5 D120

Fig 5B. 2016 Cbay densities sht2 BR110/ sht 5 D136

Fig 5C. 2018 CBay densities sht 2 bg140/sht5 150

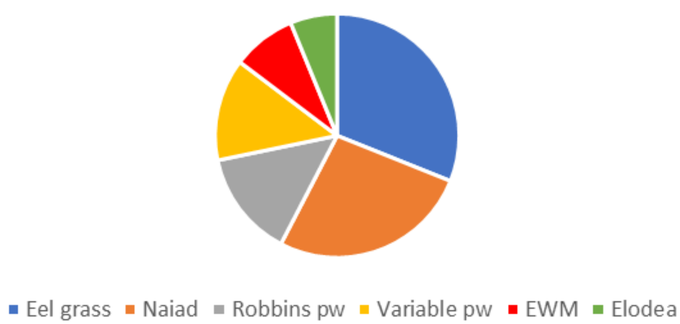
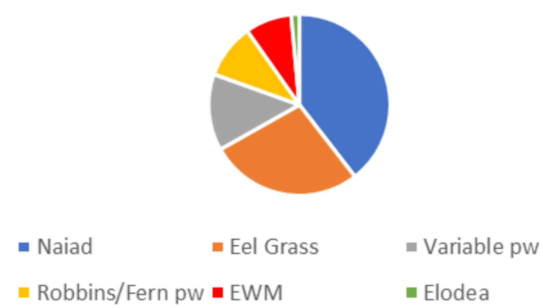


Fig 5D. 2013 SBay densities sht4 AJ50 / sht5 M120

Fig 5E. SBay 2015 densities SHT4 AJ66/ sht5 M136

Fig 5F. SBay densities 2018 SHT4 AA88/ sht5 150



Figs 6A and 6B. Comparison of aquatic plants most common in Cedarville and Sheppard Bays during a 6 year period. Sht5 D170

Fig. 6A. Shift in Cedarville Bay aquatic plants present in highest percentage measured using point-intercept analysis <ESI FINDINGS 2013 2018 sht4 CG60><sht5 D170>

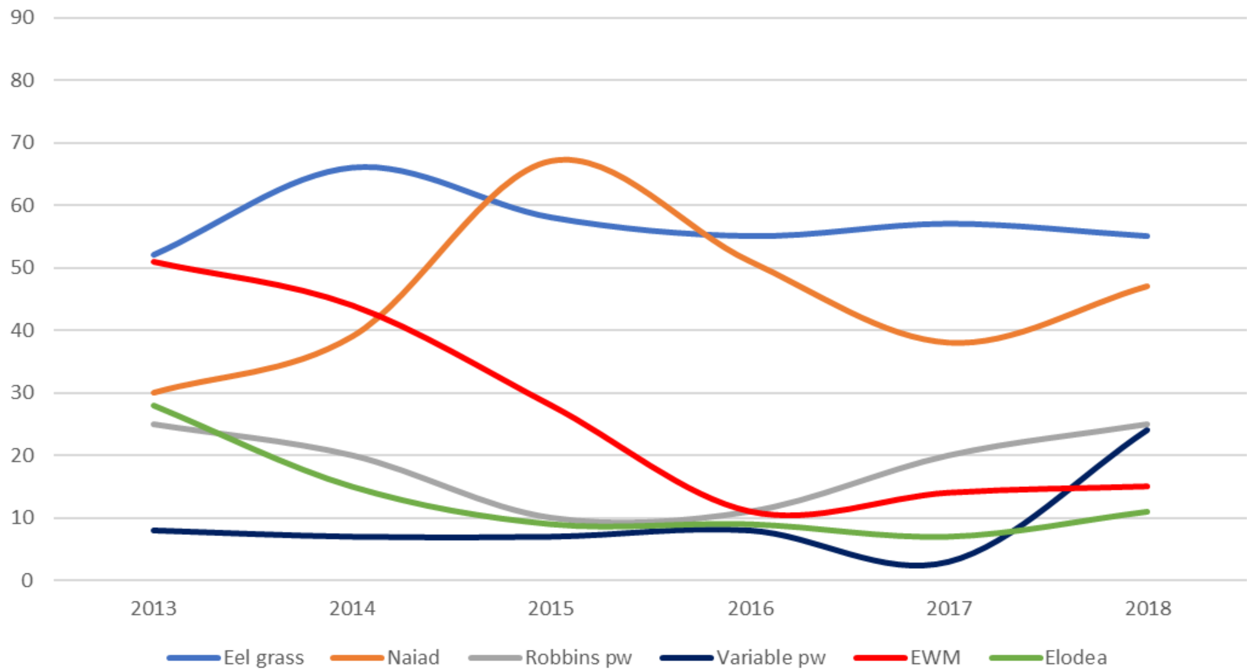
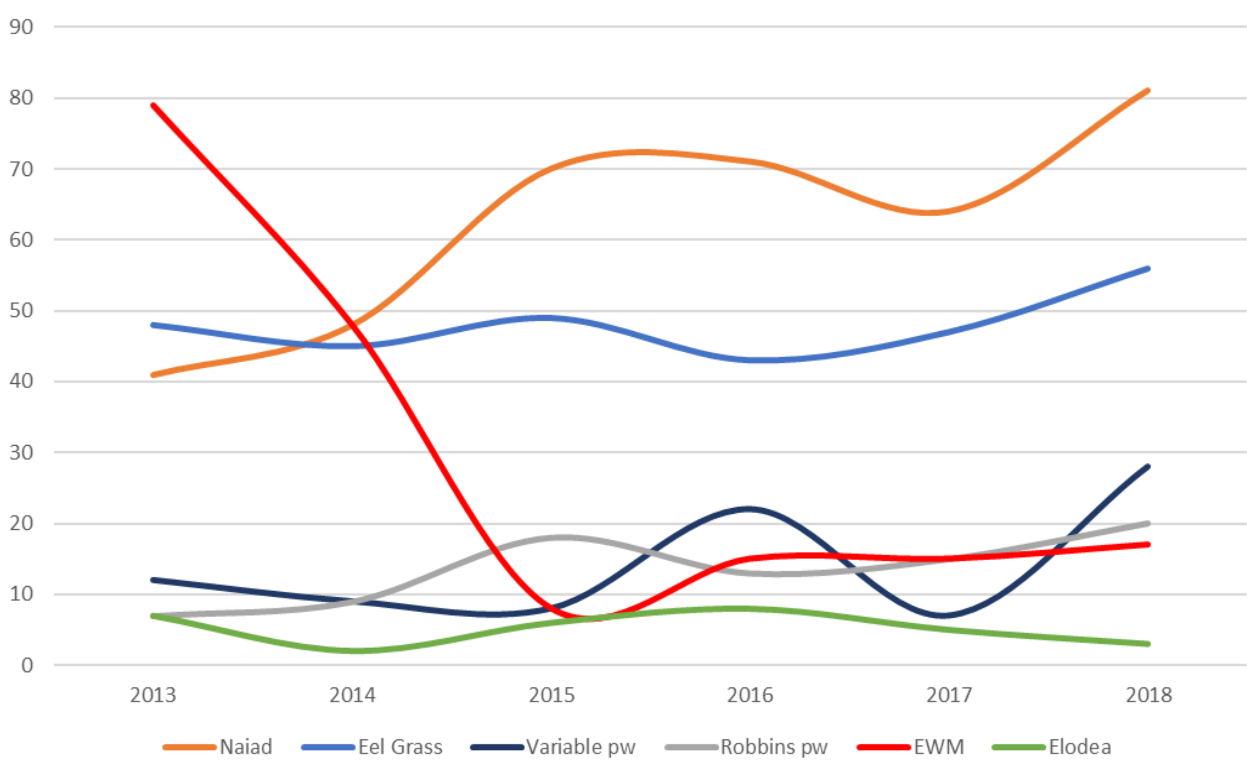


Fig. 6B. Shift in Sheppard Bay aquatic plants present in highest percentage measured using point-intercept analysis <ESI Findings 2013 2018 sht 4 CG40><sht5 D190>



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