We would like to gratefully thank the anonymous referee for your very positive and constructive comments. All suggestions have been accepted as described below.

RC = Referee's comments; AR = Authors' Response (written in blue); RS = Reconstructed sentences (written in green)

General Comments

RC1: Previous expeditions were conducted in the same region and are not mentioned in this paper. It may be important to consider and include them, which will greatly improve your description of the phytoplankton communities (Booth et al. 1997, Gosselin et al. 1997, Coupel et al. 2012).

> AR1: Thank you for the important suggestion. We included and considered the past studies indicating in-situ phytoplankton species in the similar region (Booth et al. 1997, Gosselin et al. 1997, Sukhanova et al., 2009, Joo et al., 2012, Coupel et al. 2012). These important studies were considered mainly in reconstructed section 3.1.2 as RS1.
>
> RS1: Cluster 1 contained the highest contribution of chl*b* relative to chl*a* (37%; Fig 3). The highest prasi/chl*a* ratio was also observed in this cluster (Table 1). The high amounts of chl*b* and prasi relative to chl*a* indicated that large fractions of type I or II prasinophytes occurred in this cluster. Type I prasinophytes consist of prasinoxanthin containing Prasinophyceae, and the type II prasinophytes lack prasinoxanthin but still contain high amounts of chl*b*. An example is *Micromonas pusilla*, which is widely distributed throughout the Arctic (e.g., Lovejoy et al., 2006; 2007). Joo et al. (2012) also found *Halosphaera sp.* (Prasinophyceae) was dominant at surface in the Canada Basin during summer of 2008. Vidussi et al. (2004) reported that type I prasinophytes, type II prasinophytes and chlorophytes were the major chl*b*-containing groups in Baffin Bay. However, significantly lower lut/chl*a* and zea/chl*a* ratios than that of chlorophytes found in this study (0.001 ± 0.02 and 0.011 ± 0.09, respectively) suggested that there were small fractions of chlorophytes in this cluster. Moreover, the prasi/chl*b* ratio was within the range of type I prasinophytes (e.g., Schlüter et al., 2000; Schlüter

and Møhlenberg, 2003). Therefore, we assumed that type I prasinophytes were the most dominant algal group in this cluster. The large fractions of pico-size phytoplankton chl*a* (%chl$a_{<2\mu m}$) also support the inference using HPLC pigments (Table 1). On the other hand, fuco, which is a major pigment of diatoms and haptophytes, contributed 20% to chl*a* (Fig 3). In addition, fuco/hex>1 and fuco>but (Table 1), which indicated that diatoms were the secondary contributors of chl*a* (Hill et al., 2005), rather than haptophytes, in cluster 1.

Fuco contributed the most to chl*a* in cluster 2 (~45%; Fig 3). The highest values of fuco/hex and fuco/but among all clusters (Table 1) suggest that the fraction of haptophytes was relatively small compared to that of diatoms. In addition, %chl$a_{>10\mu m}$ showed the largest contribution to the total chl*a* in this cluster (Table 1). Spatial distribution of cluster 2 was roughly matched with where large sized pennate (e.g., *Nitztschia* spp., *Flagilaria* spp., *Flagilariopsis* spp.) and centric diatoms (e.g., *Thalassiosira* spp. *and Chaetoceros* spp.) were found (Booth and Horner, 1997, Sukhanova et al., 2009, Coupel et al., 2012). Thus, we concluded that diatoms were the dominant group in this cluster compared to that of diatoms in the clusters. On the other hand, a remarkably low fuco/chl*a* ratio was observed (0.25 ± 0.072), compared to the result for diatoms by Suzuki et al. (2002) and Vidussi et al. (2004). The chl*b*/chl*a* ratio was also higher than that reported by Hill et al. (2005) in a diatom-dominated community (0.11 ± 0.04). Therefore, type I and/or II prasinophytes were the secondary groups in cluster 2. We also noted some fractions of cryptophytes due to the 15% contribution of allo to chl*a* (Jeffrey and Vesk, 1997). Sukahanova et al. (2009) reported Cryptophytes could locally dominate in the Chukchi shelf.

Fuco and hex contributed equally to chl*a* in cluster 3 (~20%; Fig 3). This result suggested that a larger fraction of haptophytes was present in cluster 3 compared to other clusters (Mackey et al., 1996; Schlüter and Møhlenberg, 2003; Hill et al., 2005). The lowest fuco/hex ratio was found in this cluster (Table 1). Additionally, hex/chl*a*, but/chl*a* and fuco/chl*a* were within the range of type I and/or II haptophytes reported by

Vidussi et al. (2004). Hence, haptophytes dominated the phytoplankton assemblages in cluster 3. These haptophyte specific pigments can be attributed by *Phaeocystis* sp. or cocolithophores reported during summer in previous studies (e.g., Sukhanova et al. 2009, Joo et al., 2012, Coupel et al., 2012). However, unfortunately we could obtain only one size fractionated chl*a* divided into cluster 3, general size structure yet unknown. Because the fuco/hex ratio did not always exceed 1.0, and the prasi/chl*a* ratio was slightly higher than in clusters 2 and 4 (Table 1), some fractions of diatoms and type I prasinophytes occurred in cluster 3. The peri/chl*a* ratio is a marker for dinoflagellates (e.g., Mackey et al., 1996; Jeffrey and Vesk, 1997). The maximum observed peri/chl*a* ratio (0.25 ± 0.11) and the ~30% contribution of peri to chl*a* (Fig 3) suggested that dinoflagellates were dominant algal group in cluster 4. Cluster 4 was also found mainly in the shallow water as well as cluster 2. It is consistint with the past studies that reported local dominance of dinoflagellate species such as *Gymnodinium* spp. and *Ceratium* spp. (Booth and Horner, 1997, Joo et al., 2012, Coupel et al., 2012). Large %chl$a_{>10\mu m}$ (Table 1) also indicated the consistency of existence of the species; dinoflagellates contribute to the fraction of larger phytoplankton biomass (Booth and Horner, 1997). The chl*b*/chl*a* and prasi/chl*b* ratios, which were similar to those in clusters 2 and 3, suggested that pasinophytes were the secondary groups (Table 1). The presence of cryptophytes was also expected based on the contribution of allo to chl*a* (Fig 3), but their abundance was most likely lower as estimated from MRA.

We thus inferred dominant phytoplankton groups (prasinophytes, diatoms, haptophytes and dinoflagellates) using MRA and CA. The presence of these four groups was consistent with the four major algal groups in the Arctic Ocean described by Sakshaug (2004). Secondarily, prasinophytes, cryptophytes and diatoms occurred in some fractions in the study area. Our results reveal the seasonal and spatial consistency with past studies that shows spatial distribution of phytoplankton assembledges in the western Arctic Ocean during summer (e.g., Bursa

1963, Booth and Horner, 1997, Lovejoy et al., 2002, 2006, 2007, Sukhanova et al., 2009, Joo et al., 2012, Coupel et al., 2012)."

RC2: This comment is related to the size-fractioned chl a according to Fujiwara et al. (2011). In the Material & Methods, you indicate that you measure at 10, 5, 2 and 0.7 um. Did you compare different size-structured classes and so different Fl, such as:
Fl10um= Chla >10/Chla total *100
Fl2um = Chla >2/Chla total *100
Fl0.7um = Chla >0.7/Chla total *100
With all these additional size-structured results, I think that you can get a better description of the size-structure of the communities. Please consider assessing the value of these other proxies. I am curious to see if you can obtain different results if you use other Fl than the one of 5 μm.

AR2: Thank you for the comment. One of the reasons why we did not consider much about size fractionated chl*a* to infer phytoplankton groups is because the lack of the sample during the cruise of 2008, which cluster 3 mainly observed. Therefore sample number is different from the other variables. Another reason is that several studies used 5μm as a criterion to divide phytoplankton size into two groups in the Arctic, (Gosselin et al., 1997, Hill et al., 2005, Ardyna et al., 2011, Ferland et al., 2011). However, as refree#1 pointed out, if we can use them, it will really improve the inferring of dominant phytoplankton groups. We calculated means and standard deviations of %chl*a* for the size classes for each cluster (Table R1 and Table 1 of the revised manuscript) with the notice that number of samples is different from HPLC pigment data. These mean community size compositions were considered to infer dominant phytoplankton groups (see reconstructed paragraphs shown in RS1).

RC3: One limitation of this paper is to consider only the surface. The authors emphasize this point in the discussion (P. 15168 L. 3-5), but it may be important to list the potential limits associated with this choice of sampling.

For example, (1) the pan-Arctic occurrence of subsurface chlorophyll maximum leads to a dichotomy in terms of phytoplankton biomass and composition between the surface and the SCM depth (Arrigo et al. 2011, Ardyna et al. 2013). A second limitation could be linked to (2) the impact of natural and seasonal succession in the Arctic phytoplankton communities, this point must also be addressed (see Bursa et al. 1963, Hsiao et al. 1983, Von Quillfeldt et al. 2000, Lovejoy et al. 2002).

AR3: Thank you for the valuable comment. We addressed the ecological and biogeochemical importance of SCM in the strongly stratified Arctic in section 4.3. Since SCM biomass is greater than that of surface communities, impact on ecosystem or biogeochemical cycles will be also greater at SCM if phytoplankton biomass or community composition changed. However, it should be noted that surface phytoplankton communities are responsive to rising of sea surface temperature, which is suggested to be the consequence of early sea-ice retreat in this study. Therefore we would like to point out the importance of responsiveness of surface phytoplankton communities to environmental change. The paragraph has been added at the end of section 4.3 as RS2.

RS2: One of the limitations of present study is that we only focused on the inter-annual variability of surface phytoplankton communities. However, recent environmental changes of the Arctic ocean likely to affect upper layer phytoplankton communities directly; sea-ice shrinking, rinsing temperature (Steele et al., 2008; Perovich and Richter-Menge, 2009), increase of river discharge (Yamamoto-Kawai et al., 2009). It thus should be pointed out the importance of favorable environment of surface phytoplankton communities. On the other hand, several studies revealed that the importance of subsurface chlorophyll-*a* maxima (SCM) in the stratified Arctic Ocean which generally co-occur with nutiricline (e.g., Tremblay et al., 2008; Martin et al., 2010; Ardyna et al., 2011). SCM contributes up to 90% of water column integrated primary production in the highly stratified and oligotrophic Arctic (Hill et al., 2013). Phytoplankton community composition is also known to be different between the two layers; pico-sized communities generally dominated at surface but larger phytoplankton dominated at SCM in contrast (Sukhanova et al., 2009; Joo et al., 2012; Coupel et al., 2012). Thus, the ecological impact of changes of phytoplankton community and its production at the SCM is seemed to be larger than those at the surface. However, since our finding suggests that surface phytoplankton community structure can change due to the rinsing of sea surface temperature consequence of early sea ice retreat, it is likely that surface phytoplankton communities are more responsive to the temporal and spatial variability of sea ice distribution than that of SCM.

General seasonal succession of phytoplankton assemblages in the Arctic was also addressed in the revised manuscript (section 4.1). We showed almost all of the samplings in this study were conducted during post-bloom condition. We believe that our findings show inter-annual variability of dominant phytoplankton assemblages during strongly stratified waters. The paragraph has been added at the end of section 4.1 as RS3.

RS3: "We would like to note that the most of our samplings have been conducted during typical post-bloom conditions. Large celled diatoms, e.g. *Fragilariopsis*, *Thalasiossila*, and *Chaetoceros*, increase their biomass, abundance and pigment concentration during spring to early summer (e.g., von Quillfeldt, 2000; Sukhanova et al., 2009; Arrigo et al., 2012). Such phytoplankton bloom generally develops from June in the southern Chukchi Sea and 1 to 2 months later in the northern waters (Wang et al., 2005). Toward late summer, phytoplankton biomass decrease with diatom abundance; on the contrary dinoflagellates or nano- and pico-sized phytoplankton become predominant both in abundance and biomass in the ice-free water (Hill et al., 2005; Sukhanova et al., 2009, Joo et al., 2012; Coupel et al., 2012). Widely spread low nutrient concentration (Figure 5) as well as low chl*a* mainly found in the northern Chukchi Sea in this study are typical characteristics of the post-bloom (e.g., Hill et al., 2005; Ardyna et al., 2013). Some fall bloom conditions were also likely to be found where high chl*a* and large diatoms were inferred to be dominant at surface. Inferred phytoplankton community compositions and their temporal and spatial distribution are consistent with previous reports. Thus, we believe that it is reasonable to discuss the distribution of dominant phytoplankton groups using algal pigment composition together with size-fractionated chl*a* measurement.

Specific Comments

RC: Please consider changing "horizontal" for "surface" throughout the manuscript.

AR: Thank you for the comment. "horizontal distribution" have been changed to "surface distribution" throughout the revised manuscript.

Introduction:

P.15154 L.24: Please change "Steel et al., 2008" for "Steele et al. 2008"

AR: Manuscript has been revised as suggested.

P. 15155 L.18-20: For the statement, "It is important to understand the influence of sea ice reduction on phytoplankton community composition because different phytoplankton functional types such as large diatoms and small flagellates play important but different roles in biogeochemical cycles and ecosystems". Please refer to previous works (e.g. Ardyna et al. 2011 and references therein).

AR: Manuscript has been revised as RS4.

RS4: It is important to understand the influence of sea ice reduction on phytoplankton community composition because different phytoplankton functional types such as large diatoms and small flagellates play important but different roles in biogeochemical cycles and ecosystems (e.g., Cushing 1989; Lochte et al., 1993; Sunda et al. 2002; Bopp et al., 2005, Ardyna et al., 2011; Leu et al. 2011).

P. 15155 L.23-24: Please modify the following sentence "And main objective is to understand how the spatial variability of sea ice distribution can affect phytoplankton community". The beginning of this sentence is not correct.

AR: Thank you for the comment. The sentence has been changed as RS5.

RS5: This study aimed at understanding how the spatial variability of sea ice distribution can affect phytoplankton community composition.

Materials & Methods:

P. 15158 L.3 Please change "CHMETAX" for "CHEMTAX".

AR: Manuscript has been revised as suggested.

Results:

P. 15159 L. 13 I am confused with the sentence including "with the depth in 2008". Do you refer perhaps to the bathymetry and not the depth?

AR: Yes, we meant bathymetry, not the water depth. All the "depth" indicate bathymetry were changed to "bathymetry".

P. 15159 L. 21 Please change "chl aratio" for "chl a ratio".

AR: Manuscript has been revised as suggested.

P. 15161 L. 20 Please change "chl a(" for "chl a (".

AR: Manuscript has been revised as suggested.

P. 15162 L. 21-24 In the Figure 5a-c, the scale of the legend is maybe not appropriate. The maximum of the nitrate concentration is 0.5 um in the legend, however you indicated in the manuscript that the maximum reached approximately 12 um. Perhaps, consider using a logarithmic scale and more importantly show the correct range in nitrate concentration in Figure 5.

AR: Figures 5a–c has reconstructed as Figure R2. Nitrate+nitrite concentration has been colored in logarithmic scaling.

Discussion:

P. 15164 Section 3.2 Did you have any correlation between salinity and nitrate concentration? In general, regions with lower salinity are characterized by stronger vertical stratification and lower surface nutrient concentrations, which are common to oligotrophic regions. On the contrary, productive regions are correlated to weak vertical stratification and rich-nutrient surface waters (see Tremblay et al. 2009a, Ardyna et al. 2011, Ferland et al. 2011 for Arctic regions).

AR: We showed the relationship between surface nitrate concentration and salinity in Figure R3. Our data revealed that nitrate tends to decrease with salinity from ~33 to ~29 ($r^2 = 0.44$ in this range). Nitrate is almost depleted at less saline water (22 to 29) and r^2 for the whole salinity range decrease to 0.26.

P. 15166 L. 24-25 “nitrogen can be a major factor limiting phytoplankton growth”. Please refer to previous works (e.g. Tremblay et al. 2008, 2009b).

AR: Tremblay et al. (2008) and Tremblay et al. (2009b) were cited in the sentence as suggested.

P. 15166 L. 24-25 “In short, diatoms and dinoflagellates with greater biomass and larger cell sizes dominated the shelf and shelf break region, where lower levels of sea-ice melt water and nutrients occurs even during the summer. In contrast, prasinophytes and haptophytes with lower biomass and/or smaller cell sizes dominated the deeper basin area (Fig. 4a–c), where the strong halocline due to the large volume of low-salinity water limits replenishment of nutrients from underlying waters (Fig. 5a–c). Please refer to previous works (e.g. Nishino et al. 2011).

AR: We agree. McLaughlin and Carmack (2010) and Nishino et al. (2011) were cited in the sentence as suggested.

P. 15167 L. 25 “However we suggest that the ecosystem can be more heterotrophic and reproductive along with increase of mixotrophic haptophytes in the western Arctic.” I disagree with this hypothesis, because novel evidences showed that the prasinophytes (such as Micromonas pusilla), which are dominant in abundance in the Western Arctic Ocean (e.g. Lovejoy et al. 2007, Balzano et al. 2012), have also the ability to be mixotrophes. The statement that the ecosystem will become more heterotrophic seems thus difficult to prove.

AR: We agree this pointing. Since we were not able to determine phytoplankton types by species level, we should not suggest the point. We decided to remove the sentence.

Table R1. Means and standard deviations of pigment/chl*a* and pigment/pigment ratios and percent contribution of size fractionated chl*a* to the total that were used in this study to determine the dominant phytoplankton groups in each cluster. Standard deviations are shown in parentheses. Note that since we obtained only one size fractionated chl*a* sample that classified into cluster 3, standard deviations are not shown for cluster 3.

Pigment	Cluster 1	Cluster 2	Cluster 3	Cluster 4
peri/chl*a*	0.023 (0.025)	0.060 (0.025)	0.041 (0.036)	0.249 (0.105)
but/chl*a*	0.030 (0.011)	0.016 (0.018)	0.029 (0.017)	0.011 (0.003)
fuco/chl*a*	0.125 (0.034)	0.25 (0.072)	0.122 (0.037)	0.096 (0.022)
hex/chl*a*	0.060 (0.022)	0.025 (0.026)	0.129 (0.060)	0.014 (0.006)
prasi/chl*a*	0.065 (0.019)	0.022 (0.007)	0.040 (0.012)	0.026 (0.011)
zea/chl*a*	0.011 (0.009)	0.011 (0.006)	0.012 (0.013)	0.009 (0.005)
lut/chl*a*	0.001 (0.002)	0.001 (0.001)	0.001 (0.002)	0.001 (0.001)
chlb/chl*a*	0.293 (0.064)	0.105 (0.039)	0.097 (0.067)	0.118 (0.039)
pras/chl*b*	0.227 (0.076)	0.222 (0.086)	0.296 (0.065)	0.210 (0.042)
fuco/hex	2.37 (1.24)	19.4 (22.5)	1.30 (0.965)	7.79 (3.93)
fuco/but	4.76 (2.50)	24.8 (24.3)	5.03 (3.28)	9.73 (3.84)
%chl$a_{>10\mu m}$	14.9 (8.71)	38.5 (20.27)	11.0 (-)	46.4 (19.33)
%chl$a_{5-10\mu m}$	6.31 (4.98)	16.8 (7.10)	7.07 (-)	7.50 (4.32)
%chl$a_{2-5\mu m}$	15.6 (6.11)	17.7 (6.79)	17.2 (-)	12.5 (5.35)
%chl$a_{<2\mu m}$	63.1 (14.96)	27.4 (9.78)	64.7 (-)	33.6 (12.07)

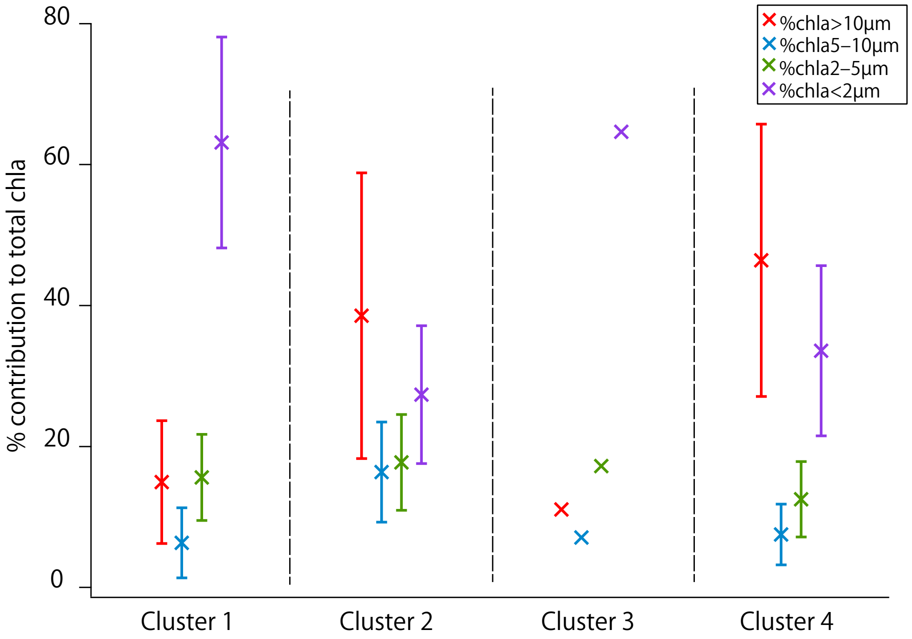

Figure R1. Mean size composition of each cluster (crossed plots) and standard deviations are shown in

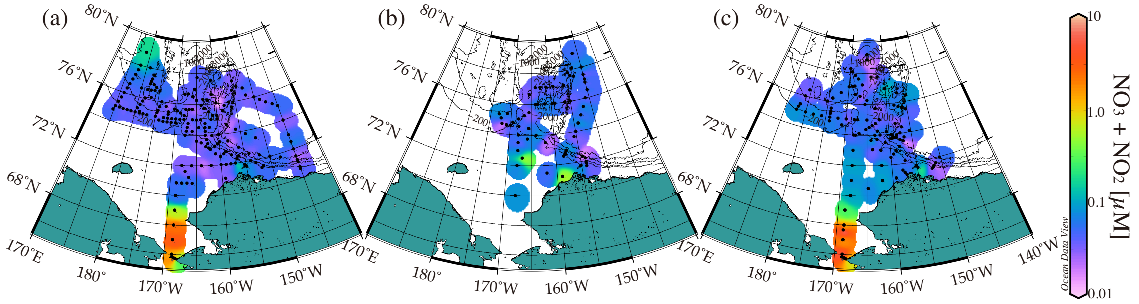

Figure R2. Surface distribution of NO_3+NO_2 in the western Arctic Ocean during late summer in (a) 2008, (b) 2009 and (c) 2010. Black dots indicate the sampling stations visited during the cruises. Depth contours indicate 200-, 1000-, 2000- and 3000-m intervals.

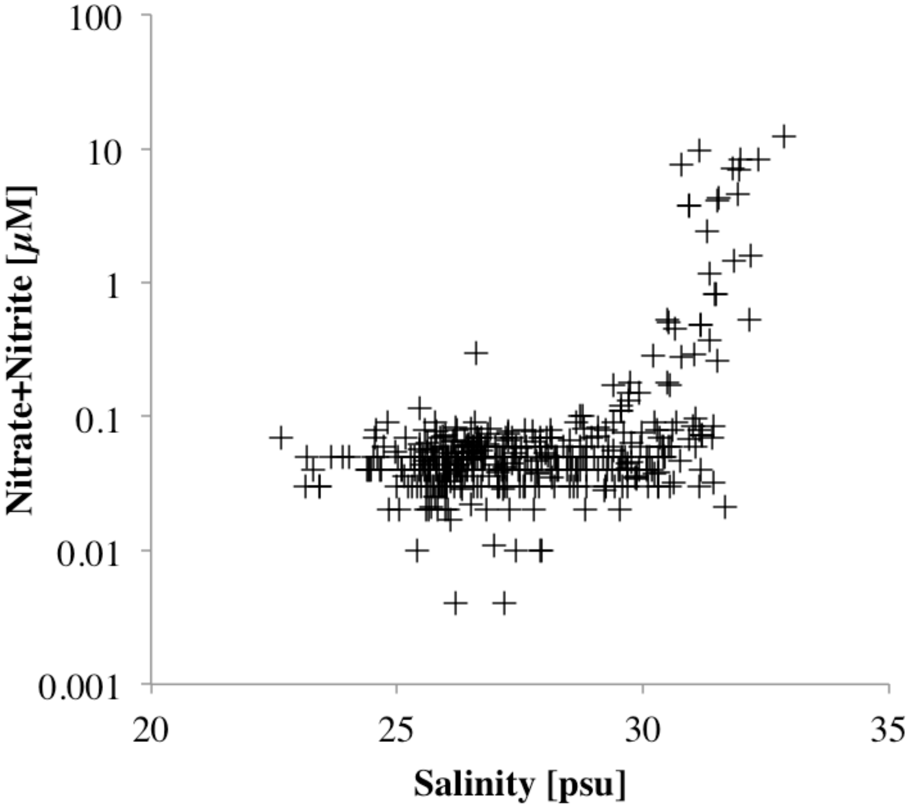

Figure R3. The relationship between surface salinity and nitrate+nitrite concentration (N=392). nitrate+nitrite is plotted in logarithmic scale.

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