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Supplementary Materials for

The Arctic Ocean as a dead end for floating plastics in the North Atlantic branch of the Thermohaline Circulation

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Supplementary Text

Fiber-type plastic in the Arctic Ocean

There is high risk of sample contamination with plastic fibers from clothing, even if the sample analyses are conducted under clean air conditions, because the vessel could act as a source of fibers during sampling. All plastic type categories peaked in the Greenland and Barents Seas, with the exception of fibers that were more uniformly distributed (Fig. 1E). The widespread occurrence of fibers suggested that either the samples could have been contaminated with fibers during sampling, or that a particular environmental factor such as wind leads to a greater dispersal of fibers. Atmospheric transport of thin plastic fibers into the Arctic could explain their common presence in the permafrost found by other authors *(9)*. However, as we could not eliminate the possibility of contamination during the whole process of sample collection and analysis, we opted to provide conservative estimates of the Arctic plastic load and discarded fibers from both weight and numerical estimates, as done in other studies *(2, 7)*. Fibers represented 26% in abundance and only 3% in mass of the total plastic collected.

Relationship between surface plastic loads and pollution sources at global scale

Considering seven basins (North and South Atlantic, North and South Pacific, Indian, Mediterranean, and Arctic), we found statistically significant correlations between total surface plastic loads per basin and both coastal population ($R = 0.78$, $p = 0.039$, $n = 7$) and presence of vessels ($R = 0.82$, $p = 0.025$, $n = 7$) (fig. S5), indicating high consistency in the data set at the global scale. However, coastal population and maritime traffic per basins were significantly correlated at global scale ($R = 0.99$, $p < 0.0001$, $n = 7$), which makes it difficult to determine the relative contribution of these pollution sources to the total plastic load. Some reports suggest that 20% of marine debris originates from marine activities and 80% from land, but this partition is not supported by rigorous data *(28)*. Yet, the relationship between coastal population and maritime traffic for the Arctic (and particularly the Greenland and Barents Seas) clearly diverged from that in other world basins, showing the highest ratio of shipping relative to population density (Table 1).

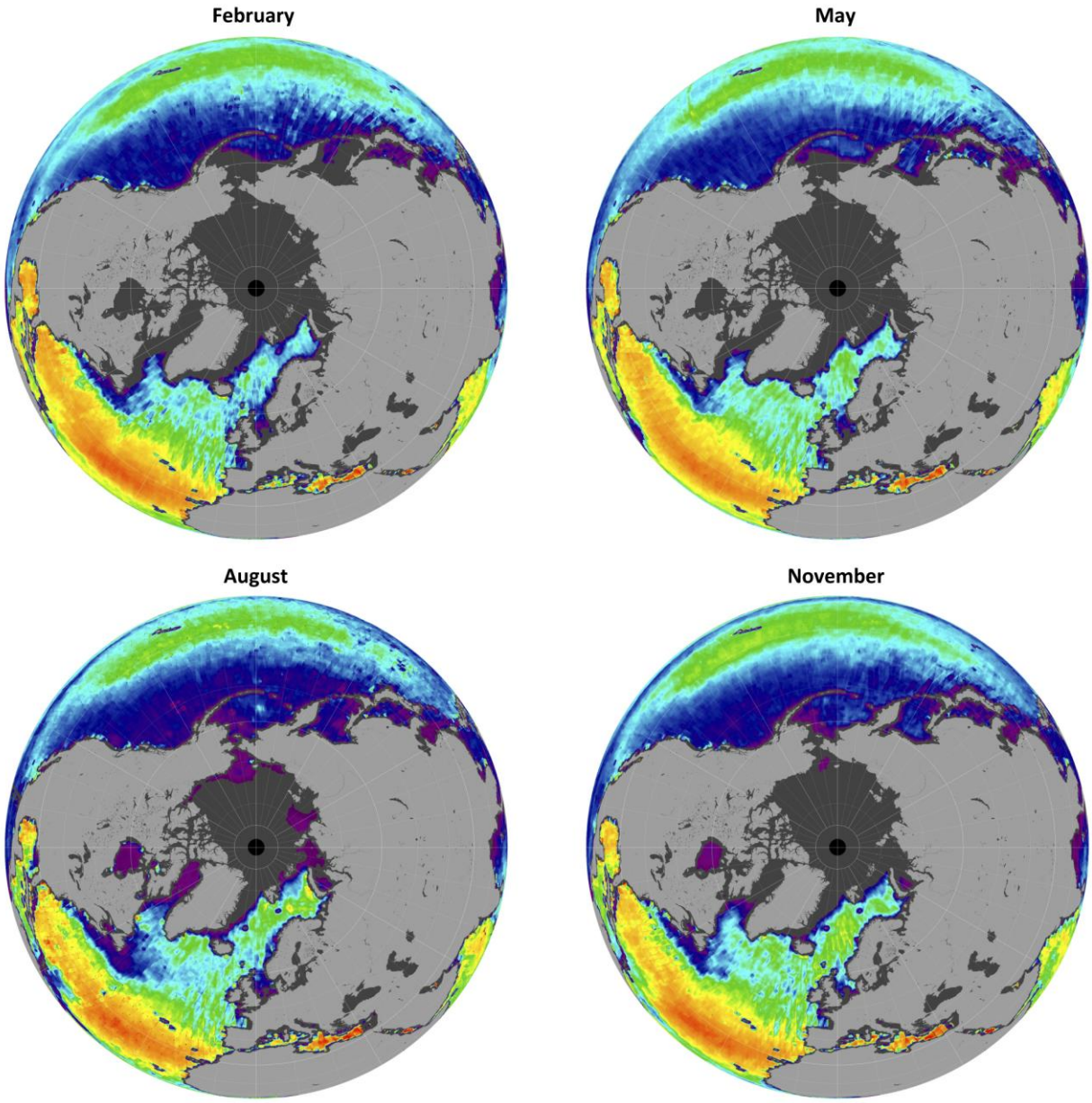

fig. S1. Seasonal cycle of ocean surface salinities for 2013 provided by the Aquarius Mission (NASA and Space Agency of Argentina; http://aquarius.umaine.edu). Color scale is shown in Fig. 1C.

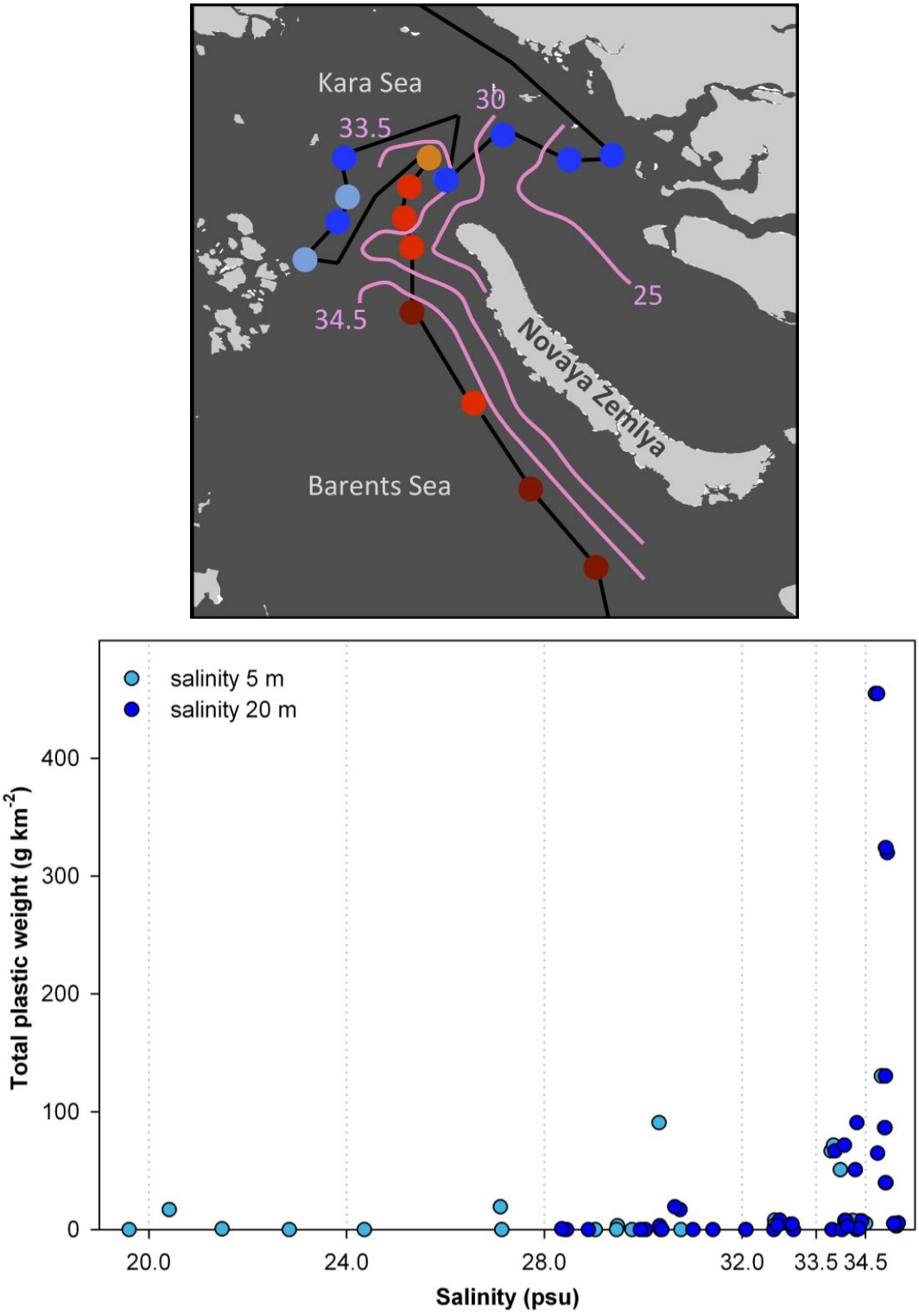

fig. S2. Relationship between salinity (depths, 5 and 20 m) and surface plastic debris measured in the present study. Note that the outlayer at 30.3 psu and 5 m depth showed 33.3 psu at 20 m depth, indicating that freshwater surface layer at this site was relatively thin. The upper map shows contour lines, interpolated by triangulation, describing salinity (5 m depth) in the zone of the front between waters of differing salinities and plastic concentrations.

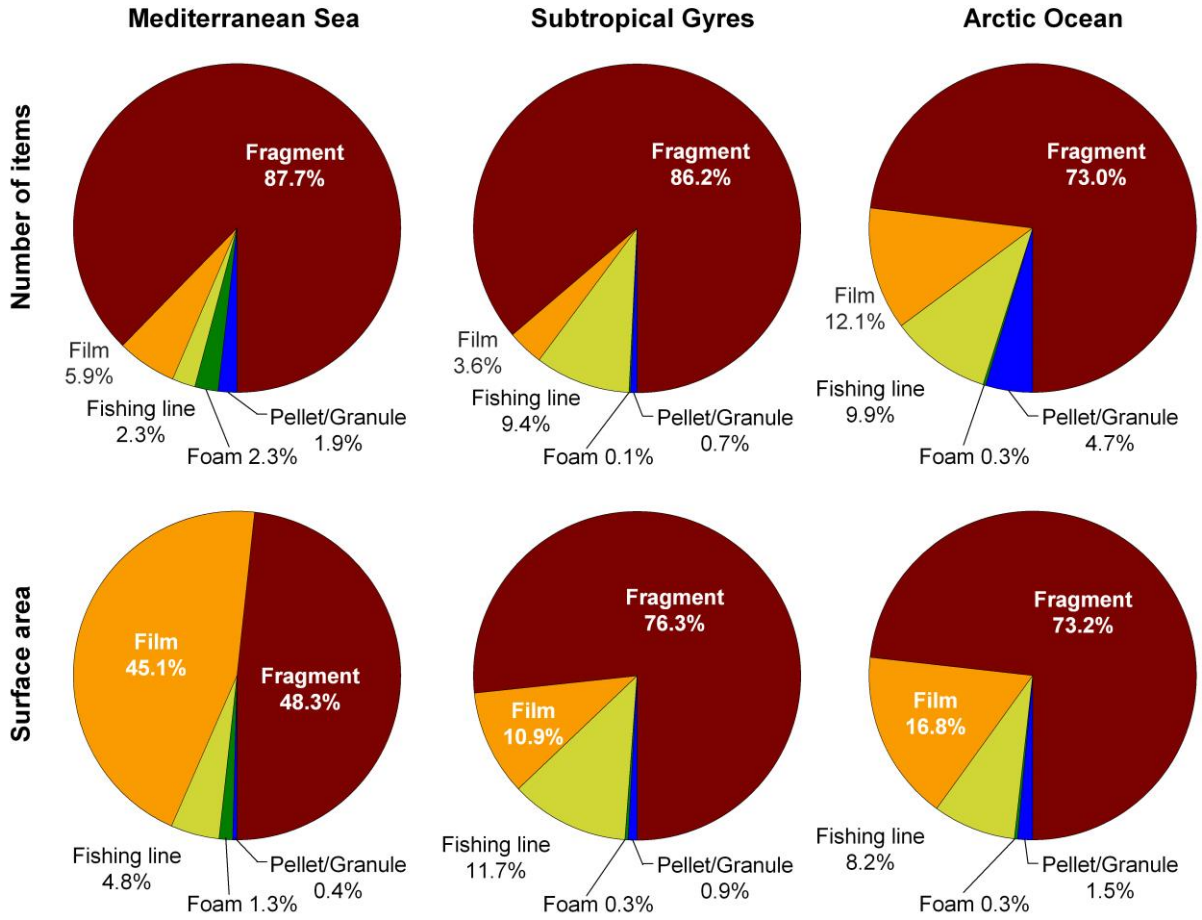

fig. S3. Pie charts in number of items (upper) and surface area (lower) of the plastic types found in the Mediterranean Sea (left), SOGs (center), and Arctic Ocean (right). Images of the different categories are shown in fig. S4. Sample collections for SOGs (4173 items) and Mediterranean (3854 items) are described in previous reports (*2*, *7*). The pieces of plastic film were particularly small in the Arctic, and large in the Mediterranean, the region with the shortest pathway to potentially important sources of debris.

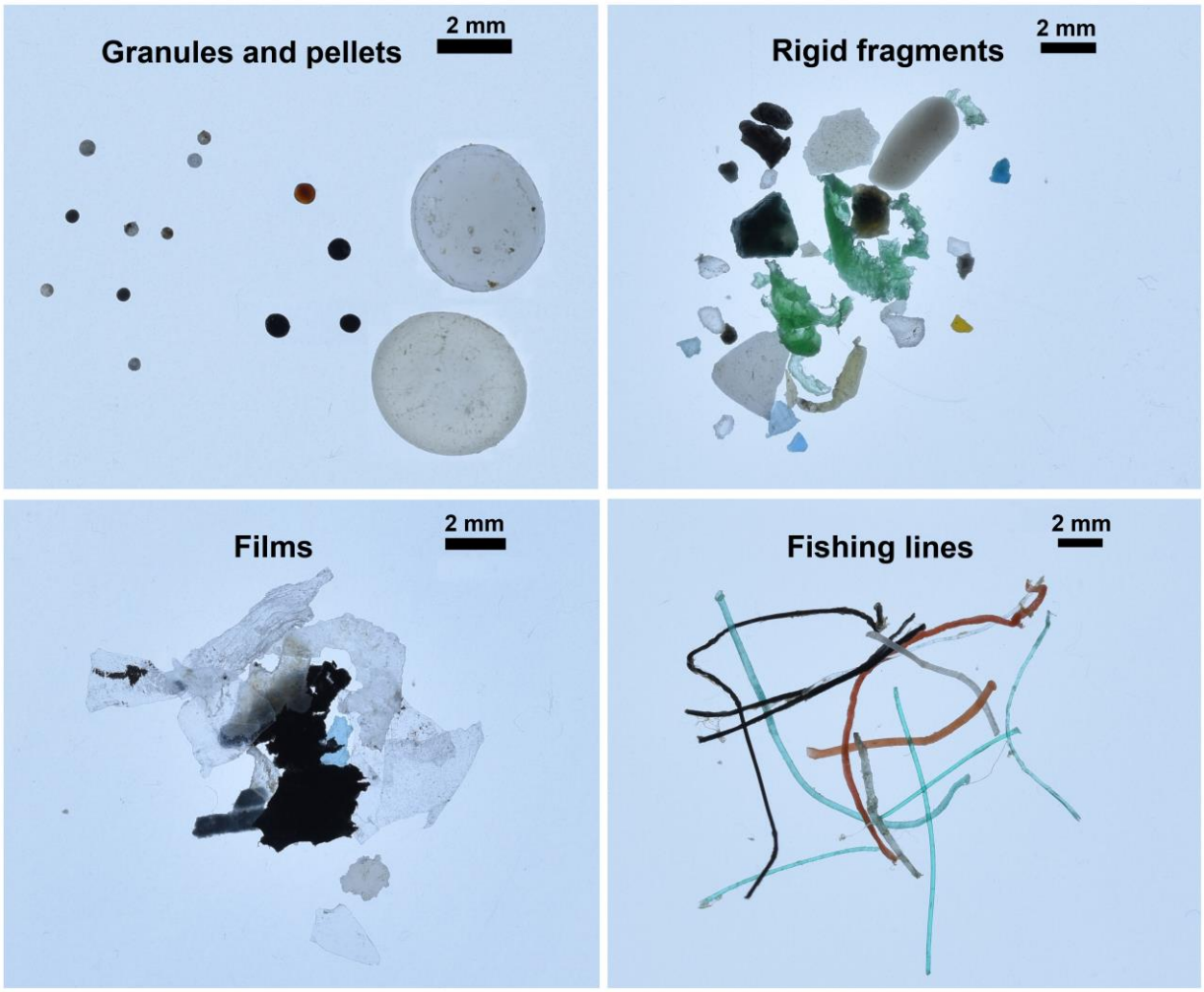

fig. S4. Images of different categories of microplastics found in the Arctic Ocean. Granules were grouped together with industrial raw pellets, although the former are generally quite smaller than pellets.

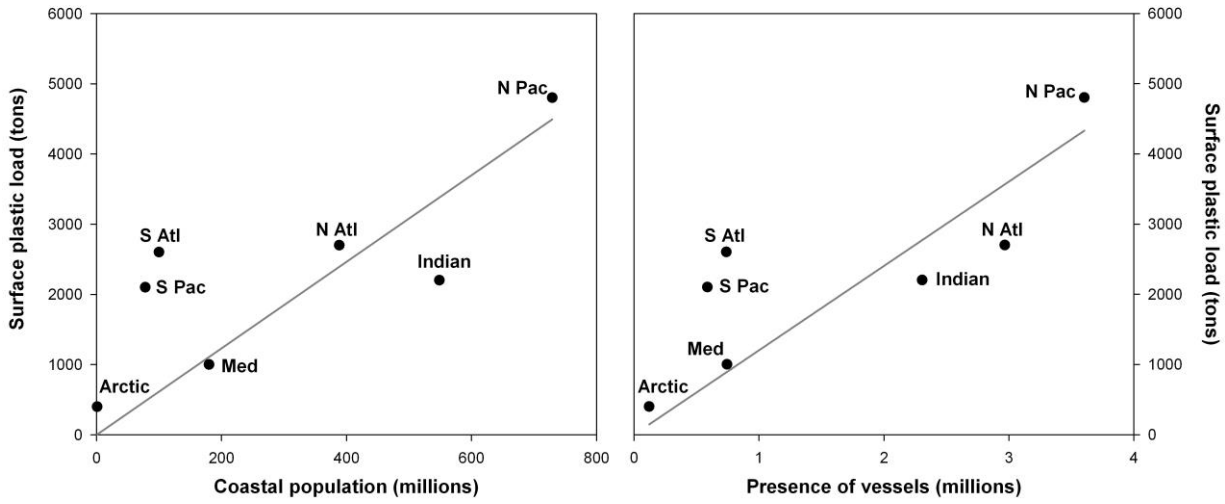

fig. S5. Relationship between the estimates of total surface plastic load [(*2*, *7*); this work], coastal population, and presence of vessels per great basins: Arctic, Mediterranean (Med), North Atlantic (N Atl), South Atlantic (S Atl), North Pacific (N Pac), South Pacific (S Pac), and Indian Ocean. Straight lines represent the ordinary least squares regression fitted to total surface plastic loads per basin as a function of coastal population (R = 0.78, p = 0.039, n = 7) and presence of vessels (R = 0.82, p = 0.025, n = 7). The Southern Ocean was not included in the analysis due to the lack of data, although available studies suggest scarce plastic pollution for that basin *(29)*.

table S1. Size distribution of floating plastic debris collected for the present study. Number of items in each bin (excluding fibers).

Lower size	Upper size	Plastic items
0.32	0.40	5
0.40	0.50	10
0.50	0.63	29
0.63	0.79	41
0.79	1.00	67
1.00	1.26	97
1.26	1.58	85
1.58	2.00	98
2.00	2.51	76
2.51	3.16	89
3.16	3.98	51
3.98	5.01	48
5.01	6.31	28
6.31	7.94	18
7.94	10.0	19
10.0	12.6	18
12.6	15.9	9
15.9	20.0	4
20.0	25.1	1
25.1	31.6	1
31.6	860	2

table S2. Number of items per tow (fibers, nonfibers, and total items) and concentrations in abundance and weight per square kilometer (excluding fibers).

Vessel	Latitude (º)	Longitude (º)	Date	# fibers	# non-fibers	# total items	# km^{-2}	g km^{-2}
Tara	67.206	00.257	04/06/13	4	3	7	4917	3.0
Tara	68.994	02.165	05/06/13	6	10	16	6878	5.4
Tara	70.369	03.731	06/06/13	9	4	13	2884	5.1
Tara	74.168	03.910	08/06/13	7	316	323	133815	39.6
Tara	76.072	02.087	09/06/13	9	14	23	112614	130.2
Tara	71.049	38.691	30/06/13	0	9	9	63093	64.7
Tara	72.604	44.136	02/07/13	0	41	41	236952	319.7
Tara	74.389	47.137	03/07/13	0	101	101	239525	323.9
Tara	75.952	51.927	04/07/13	5	27	32	30505	86.3
Tara	77.582	58.474	05/07/13	16	94	110	317091	454.6
Tara	77.756	65.405	13/07/13	3	102	105	76152	90.7
Tara	77.982	67.800	06/07/13	13	16	29	64756	66.7
Tara	77.912	71.746	14/07/13	1	12	13	68568	71.5
Tara	77.439	75.731	05/08/13	6	9	15	26568	50.8
Tara	79.673	60.990	11/08/13	15	2	17	10241	7.2
Tara	79.203	66.575	10/07/13	25	4	29	3762	0.8
Tara	79.015	69.710	06/08/13	3	2	5	1777	7.6
Tara	77.256	73.256	15/07/13	9	0	9	0	0.0
Tara	79.082	74.263	12/08/13	11	0	11	0	0.0
Tara	75.973	78.509	04/08/13	1	0	1	0	0.0
Tara	74.811	76.166	18/07/13	11	0	11	0	0.0
Tara	73.964	77.072	19/07/13	5	0	5	0	0.0
Tara	77.925	116.912	27/08/13	4	0	4	0	0.0
Tara	73.824	145.776	02/09/13	0	1	1	20665	16.8
Tara	71.511	160.987	03/09/13	7	0	7	0	0.0
Tara	70.714	166.290	04/09/13	6	0	6	0	0.0
Tara	71.159	174.810	08/09/13	3	0	3	0	0.0
Tara	72.207	-158.277	13/09/13	10	1	11	23144	19.3
Tara	71.875	-153.075	15/09/13	2	0	2	0	0.0
Tara	71.332	-147.298	16/09/13	0	0	0	0	0.0
Tara	71.478	-140.102	16/09/13	16	1	17	762	0.5
Tara	71.981	-92.449	27/09/13	11	1	12	3059	3.2
Tara	73.148	-83.033	03/10/13	3	0	3	0	0.0
Tara	73.067	-79.639	05/10/13	13	0	13	0	0.0

Tara	72.675	-77.544	06/10/13	14	0	14	0	0.0
Tara	70.946	-52.478	12/10/13	9	0	9	0	0.0
Tara	69.203	-51.147	15/10/13	12	5	17	11136	8.0
Tara	69.113	-50.364	20/10/13	3	2	5	7041	4.6
Tara	64.688	-52.034	23/10/13	6	1	7	5794	3.6
Tara	61.522	-54.011	27/10/13	2	7	9	3966	2.6
Pakea Bizkaia	60.46	-49.54	12/06/11		1	1	1542	5.09
Pakea Bizkaia	63.57	-53.12	15/06/11		8	8	14251	7.76