

litteR - Analysis of Litter Data

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Introduction

This tool performs the following types of data analysis on beach litter data, or any other type of litter data: data quality control, outlier analysis, descriptive statistics, and trend analysis.

This report can best be viewed with the latest versions of web browsers like Google Chrome, Mozilla Firefox, Chromium, or Safari. Its contents does not render well in some versions of Microsoft's Internet Explorer.

Settings

- period: from 2016-01-01 to 2021-12-31
- percentage of total count to analyse: 100%
- files:
 - project directory: 'C:/Users/evbl/Desktop/IB2024_OS'
 - settings: 'settings_OS.yaml'
 - data: 'Data_file.csv'
 - types: 'Category_file.csv'
- location codes: 'Malarhusen', 'Nybrostrand', 'Sjauster', 'Tofta', 'Nattaro', 'Storsand', 'Rullsand' and 'Karehamn'
- region codes: 'OS'
- group codes: 'PLAST', 'TYG', 'METALL', 'PAPPER.KARTONG', 'GUMMI', 'TRA', 'GLAS.KERAMIK', 'SANITET.MEDICINSKT', 'ORGANISKT', 'KEMISKA.FORORENINGAR', 'OLIKA.MATERIAL', 'SUP' and 'FISH'
- type names: not specified
- figure quality: 'high'
- cutoff count axis in plots: 100%

Data Quality Control

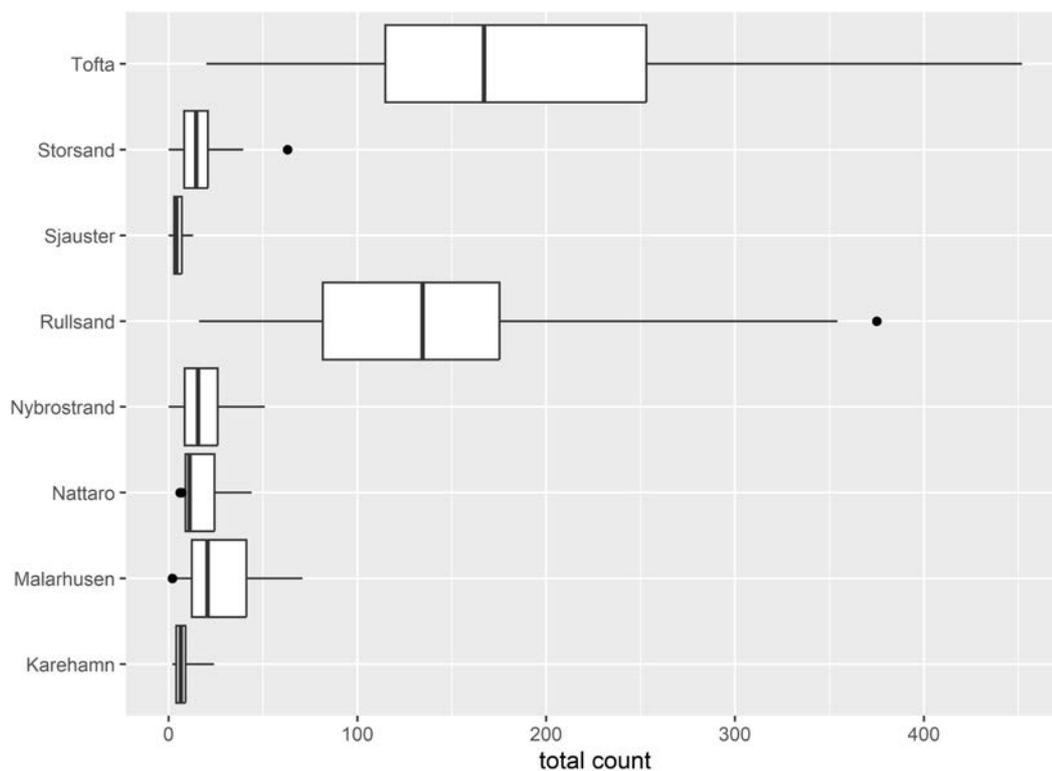
In this section, litter data will be read and validated. Warnings will be printed if they occur. See also the log-file for more details.

```
Warning: The following columns will be excluded from analysis:  
'kat_ot01'
```

Warning: The following record(s) contain(s) only zeroes:
 36, 97 and 137.
 Please, verify if this correct.
 These record(s) will be included in the analysis.

Outlier analysis

For each `location_code`, adjusted boxplots (<https://dx.doi.org/doi:10.1016/j.csda.2007.11.008>) are given of the total count for outliers (<https://en.wikipedia.org/wiki/Outlier>) detection in the period 2016-01-01 to 2021-12-31. Outliers are given as dots (if any) in the adjusted box-and-whisker plots below. Note that outliers are not necessarily errors.



Outliers, if available, are listed in the table below. In addition, also the number of surveys `n` is reported. Litter experts should decide if outliers are errors and need to be excluded from analysis. Note, however, that due to its non-parametric nature, `litterR` is fairly robust for outliers.

<code>location_code</code>	<code>date</code>	<code>n</code>	<code>total count</code>
Malarhusen	2020-10-28	18	2
Nattaro	2017-05-02	18	6
Nattaro	2018-11-01	18	6
Nattaro	2016-04-28	18	7
Nattaro	2016-10-31	18	7
Rullсанд	2020-07-19	18	375
Storsand	2021-08-01	18	63

Descriptive statistics

Basic statistics

The number of years and the number of surveys for each `location_code` should not be too small, otherwise the calculations in this report will be less reliable. In addition, the surveys should ideally also be evenly spread in time.

Note that **litteR** does not enforce a minimum number of years or surveys. That is the responsibility of the user. As a guideline, we advise a minimum of 5 years and 10 surveys, evenly distributed in time.

The table below gives the number of surveys and the number of years for each `location_code`.

region_code	location_code	number of years	number of surveys
OS	Karehamn	6	18
OS	Malarhusen	6	18
OS	Nattaro	6	18
OS	Nybrostrand	6	18
OS	Rullsand	6	18
OS	Sjauster	6	18
OS	Storsand	6	18
OS	Tofta	6	18

For each location code and group/type name, the following statistics have been estimated for the period 2016-01-01 to 2021-12-31:

- mean count (`mean`), *i.e.*, the arithmetic mean (https://en.wikipedia.org/wiki/Arithmetic_mean) of the counts for each litter type;
- median count (`median`), *i.e.*, the median (<https://en.wikipedia.org/wiki/Median>) of the counts for each litter type;
- relative count (`%TC`): the contribution of each litter type to the total count of litter types (%);
- coefficient of variation (https://en.wikipedia.org/wiki/Coefficient_of_variation) (`cv`): the ratio of the standard deviation to the mean of the counts for each litter type (expressed as a fraction);
- ratio of mad (https://en.wikipedia.org/wiki/Median_absolute_deviation) and median (<https://en.wikipedia.org/wiki/Median>) (`rmad` , expressed as a fraction);
- number of surveys (`n`);
- Theil-Sen slope (https://en.wikipedia.org/wiki/Theil%E2%80%93Sen_estimator) (slope): a robust non-parametric estimator of slope (litter counts / year);
- p-value (<https://en.wikipedia.org/wiki/P-value>): the p-value associated with the one-tailed Mann-Kendall test (https://en.wikipedia.org/wiki/Kendall_rank_correlation_coefficient) to test the null hypothesis of
 - no monotonically *increasing* trend in case the Theil-Sen slope is greater than zero;
 - no monotonically *decreasing* trend in case the Theil-Sen slope is smaller than zero;

These statistics will be estimated for litter types with the greatest counts making up 100% of the total count for each location and for all groups specified in 'Category_file.csv'.

These statistics have been stored in file 'litteR-results-20230328T154901.csv'.

The statistics for the litter groups are given in the table below. These group statistics are based on *all* litter types and not only on those types with the highest counts.

location_code	from	to	group_code	%TC	mean	median	cv	rmad	n	slope	p-value
Karehamn	2016-04-22	2021-10-27	TC	100	8.722	6.5	0.7883	0.5702	18	0.2497	0.2969
Karehamn	2016-04-22	2021-10-27	PLAST	65.87	5.778	4	0.8776	0.7413	18	0	0.5758
Karehamn	2016-04-22	2021-10-27	SUP	14.03	1.333	1	1.409	1.483	18	0	0.1860
Karehamn	2016-04-22	2021-10-27	METALL	10.54	0.7222	0	1.327	NA	18	0	0.8899
Karehamn	2016-04-22	2021-10-27	TRA	8.814	0.6111	0.5	1.142	1.483	18	0	0.0415
Karehamn	2016-04-22	2021-10-27	FISH	5.823	0.7222	0	1.561	NA	18	0	0.6815
Karehamn	2016-04-22	2021-10-27	TYG	3.958	0.3889	0	2.185	NA	18	0	0.3182
Karehamn	2016-04-22	2021-10-27	GUMMI	3.34	0.3889	0	2.357	NA	18	0	0.8922
Karehamn	2016-04-22	2021-10-27	ORGANISKT	2.855	0.2778	0	2.068	NA	18	0	0.5628
Karehamn	2016-04-22	2021-10-27	GLAS.KERAMIK	2.83	0.2778	0	2.068	NA	18	0	0.6825
Karehamn	2016-04-22	2021-10-27	PAPPER.KARTONG	1.798	0.2778	0	2.707	NA	18	0	0.4298
Karehamn	2016-04-22	2021-10-27	OLIKA.MATERIAL	0	0	0	NA	NA	18	0	NA
Karehamn	2016-04-22	2021-10-27	SANITET.MEDICINSKT	0	0	0	NA	NA	18	0	NA
Malarhusen	2016-04-18	2021-11-07	TC	100	27.89	20.5	0.7413	0.7594	18	1.494	0.3110
Malarhusen	2016-04-18	2021-11-07	PLAST	64.67	17.06	12.5	0.7496	0.771	18	2.609	0.0798
Malarhusen	2016-04-18	2021-11-07	SUP	19.04	4.611	3	1.052	0.9884	18	0.1901	0.2697
Malarhusen	2016-04-18	2021-11-07	FISH	16.19	3.5	2.5	1.181	0.8896	18	0	0.7057

location_code	from	to	group_code	%TC	mean	median	cv	rmad	n	slope	p-value
Malarhusen	2016-04-18	2021-11-07	ORGANISKT	9.331	4.667	0.5	2.233	1.483	18	0	0.6876
Malarhusen	2016-04-18	2021-11-07	TYG	6.537	1.444	1	0.6382	0.7413	18	0	0.7313
Malarhusen	2016-04-18	2021-11-07	METALL	5.617	0.9444	0.5	1.561	1.483	18	0	0.2541
Malarhusen	2016-04-18	2021-11-07	GUMMI	3.581	1.167	0.5	1.695	1.483	18	0	0.9197
Malarhusen	2016-04-18	2021-11-07	TRA	3.302	0.8333	0	1.318	NA	18	0	0.7080
Malarhusen	2016-04-18	2021-11-07	PAPPER.KARTONG	2.481	0.8333	0	1.758	NA	18	0	0.6690
Malarhusen	2016-04-18	2021-11-07	OLIKA.MATERIAL	2.37	0.3889	0	3.073	NA	18	0	0.0258
Malarhusen	2016-04-18	2021-11-07	GLAS.KERAMIK	2.11	0.5556	0	2.068	NA	18	0	0.1221
Malarhusen	2016-04-18	2021-11-07	SANITET.MEDICINSKT	1.911	0.7222	0	2.317	NA	18	0	0.8758
Nattaro	2016-04-28	2021-10-28	TC	100	17.56	11	0.7126	0.6065	18	1.148	0.0856
Nattaro	2016-04-28	2021-10-28	PLAST	62.02	11	8	0.7587	0.834	18	1.023	0.0509
Nattaro	2016-04-28	2021-10-28	SUP	42.3	7.944	6.5	0.8726	0.9124	18	0.998	0.0957
Nattaro	2016-04-28	2021-10-28	METALL	10.47	1.611	1.5	1.002	1.483	18	0	0.6383
Nattaro	2016-04-28	2021-10-28	GUMMI	6.759	0.6111	0	1.787	NA	18	0	0.1928
Nattaro	2016-04-28	2021-10-28	TYG	5.084	1.333	0	1.586	NA	18	0	0.6928
Nattaro	2016-04-28	2021-10-28	TRA	4.955	0.8333	0	1.941	NA	18	0	0.1035
Nattaro	2016-04-28	2021-10-28	FISH	4.453	0.6111	0	1.272	NA	18	0	0.0934
Nattaro	2016-04-28	2021-10-28	ORGANISKT	4.383	1.056	0	1.989	NA	18	0	0.5955
Nattaro	2016-04-28	2021-10-28	GLAS.KERAMIK	3.897	0.5556	0	2.158	NA	18	0	0.3765
Nattaro	2016-04-28	2021-10-28	SANITET.MEDICINSKT	2.732	0.6667	0	2.243	NA	18	0	0.8673
Nattaro	2016-04-28	2021-10-28	PAPPER.KARTONG	2.427	0.5556	0	2.158	NA	18	0	0.4582

location_code	from	to	group_code	%TC	mean	median	cv	rmad	n	slope	p-value
Nattaro	2016-04-28	2021-10-28	OLIKA.MATERIAL	0	0	0	NA	NA	18	0	NA
Nybrostrand	2016-05-03	2021-10-23	FISH	NaN	1.167	1	0.9413	1.483	18	-0.3823	0.0022
Nybrostrand	2016-05-03	2021-10-23	GLAS.KERAMIK	NaN	0.9444	0.5	1.603	1.483	18	0	0.0187
Nybrostrand	2016-05-03	2021-10-23	GUMMI	NaN	0.5556	0	1.875	NA	18	0	0.0186
Nybrostrand	2016-05-03	2021-10-23	METALL	NaN	1.556	1	1.171	1.483	18	-0.5159	0.0073
Nybrostrand	2016-05-03	2021-10-23	OLIKA.MATERIAL	NaN	0.05556	0	4.243	NA	18	0	0.1445
Nybrostrand	2016-05-03	2021-10-23	ORGANISKT	NaN	0.4444	0	2.344	NA	18	0	0.3841
Nybrostrand	2016-05-03	2021-10-23	PAPPER.KARTONG	NaN	0.3333	0	2.058	NA	18	0	0.0857
Nybrostrand	2016-05-03	2021-10-23	PLAST	NaN	11.61	9.5	0.7392	1.014	18	-2.474	0.0264
Nybrostrand	2016-05-03	2021-10-23	SANITET.MEDICINSKT	NaN	0.1667	0	2.301	NA	18	0	0.8430
Nybrostrand	2016-05-03	2021-10-23	SUP	NaN	4.833	4.5	0.7684	0.6589	18	-0.8844	0.0237
Nybrostrand	2016-05-03	2021-10-23	TC	NaN	17.78	15.5	0.7449	0.7652	18	-4.132	0.0084
Nybrostrand	2016-05-03	2021-10-23	TRA	NaN	1.5	1	1.258	1.483	18	0	0.0927
Nybrostrand	2016-05-03	2021-10-23	TYG	NaN	0.7778	0.5	1.212	1.483	18	0	0.6296
Rullsand	2016-04-18	2021-10-24	TC	100	151.8	134.5	0.659	0.5512	18	20.95	0.0287
Rullsand	2016-04-18	2021-10-24	PLAST	70.07	104.3	92	0.6378	0.5479	18	15.2	0.0244
Rullsand	2016-04-18	2021-10-24	SUP	27.11	46.33	34	0.9398	0.7413	18	6.576	0.0477
Rullsand	2016-04-18	2021-10-24	METALL	8.508	10.17	8	0.6251	0.6486	18	-0.4498	0.2835
Rullsand	2016-04-18	2021-10-24	PAPPER.KARTONG	7.797	15.61	6	1.269	0.9884	18	1.252	0.1115
Rullsand	2016-04-18	2021-10-24	FISH	6.005	7.278	4.5	0.7538	0.8237	18	1.623	0.0198
Rullsand	2016-04-18	2021-10-24	TRA	5.732	8.389	7.5	0.7384	0.8896	18	1.09	0.0859

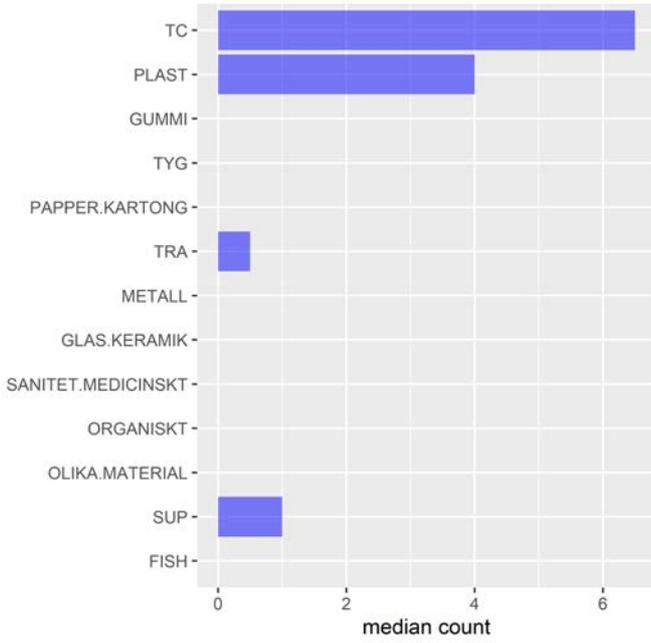
location_code	from	to	group_code	%TC	mean	median	cv	rmd	n	slope	p-value
Rullsand	2016-04-18	2021-10-24	SANITET.MEDICINSKT	4.477	6.556	4.5	0.9319	1.153	18	0.903	0.0335
Rullsand	2016-04-18	2021-10-24	ORGANISKT	3.235	6.111	3	1.223	1.483	18	1.269	0.0139
Rullsand	2016-04-18	2021-10-24	TYG	2.395	3.722	3	0.8877	1.483	18	0.4049	0.1036
Rullsand	2016-04-18	2021-10-24	GUMMI	1.748	2.778	1.5	1.08	1.483	18	0.8245	0.0074
Rullsand	2016-04-18	2021-10-24	OLIKA.MATERIAL	0.3404	0.5556	0	3.394	NA	18	0	0.0338
Rullsand	2016-04-18	2021-10-24	GLAS.KERAMIK	0.1752	0.1667	0	3.087	NA	18	0	0.6881
Sjauster	2016-04-18	2021-10-27	FISH	NaN	0.05556	0	4.243	NA	18	0	0.0507
Sjauster	2016-04-18	2021-10-27	GLAS.KERAMIK	NaN	0.2222	0	1.925	NA	18	0	0.3355
Sjauster	2016-04-18	2021-10-27	GUMMI	NaN	0.05556	0	4.243	NA	18	0	0.7500
Sjauster	2016-04-18	2021-10-27	METALL	NaN	0.2778	0	1.659	NA	18	0	0.0423
Sjauster	2016-04-18	2021-10-27	OLIKA.MATERIAL	NaN	0.1667	0	3.087	NA	18	0	0.2204
Sjauster	2016-04-18	2021-10-27	ORGANISKT	NaN	0.05556	0	4.243	NA	18	0	0.8071
Sjauster	2016-04-18	2021-10-27	PAPPER.KARTONG	NaN	0.2778	0	2.975	NA	18	0	0.9294
Sjauster	2016-04-18	2021-10-27	PLAST	NaN	2.889	3	0.9111	0.9884	18	0	0.5000
Sjauster	2016-04-18	2021-10-27	SANITET.MEDICINSKT	NaN	0.2778	0	2.409	NA	18	0	0.5235
Sjauster	2016-04-18	2021-10-27	SUP	NaN	1.167	1	1.221	1.483	18	0	0.0787
Sjauster	2016-04-18	2021-10-27	TC	NaN	4.889	4	0.6652	0.7413	18	-0.3054	0.2321
Sjauster	2016-04-18	2021-10-27	TRA	NaN	0.1667	0	3.087	NA	18	0	0.0535
Sjauster	2016-04-18	2021-10-27	TYG	NaN	0.7778	0	1.433	NA	18	0	0.1252
Storsand	2016-05-18	2021-10-19	FISH	NaN	1.389	1	0.9609	1.483	18	0	0.2267
Storsand	2016-05-18	2021-10-19	GLAS.KERAMIK	NaN	0	0	NA	NA	18	0	NA

location_code	from	to	group_code	%TC	mean	median	cv	rmad	n	slope	p-value
Storsand	2016-05-18	2021-10-19	GUMMI	NaN	0.2222	0	2.467	NA	18	0	0.7022
Storsand	2016-05-18	2021-10-19	METALL	NaN	0.2222	0	2.467	NA	18	0	0.6601
Storsand	2016-05-18	2021-10-19	OLIKA.MATERIAL	NaN	0.05556	0	4.243	NA	18	0	0.5384
Storsand	2016-05-18	2021-10-19	ORGANISKT	NaN	2.889	1	1.561	1.483	18	0	0.8932
Storsand	2016-05-18	2021-10-19	PAPPER.KARTONG	NaN	2.111	2	0.9733	1.483	18	-0.2279	0.1456
Storsand	2016-05-18	2021-10-19	PLAST	NaN	9.889	8	0.8229	0.6486	18	-0.5108	0.3241
Storsand	2016-05-18	2021-10-19	SANITET.MEDICINSKT	NaN	0.2222	0	3.294	NA	18	0	0.9465
Storsand	2016-05-18	2021-10-19	SUP	NaN	3.667	3	0.9494	1.483	18	0	0.6782
Storsand	2016-05-18	2021-10-19	TC	NaN	17.06	14.5	0.8168	0.6646	18	-0.6659	0.2844
Storsand	2016-05-18	2021-10-19	TRA	NaN	1.167	0	1.506	NA	18	-0.4976	0.0008
Storsand	2016-05-18	2021-10-19	TYG	NaN	0.5	0	2.849	NA	18	0	0.7855
Tofta	2016-04-20	2021-10-27	TC	100	180.6	167	0.6069	0.7546	18	-7.551	0.2721
Tofta	2016-04-20	2021-10-27	PLAST	68.61	117.6	112	0.605	0.6023	18	0.5746	0.4397
Tofta	2016-04-20	2021-10-27	SUP	33.85	60.33	61.5	0.652	0.458	18	-0.7454	0.3521
Tofta	2016-04-20	2021-10-27	METALL	11.97	22.61	18	0.8815	0.8649	18	-2.786	0.1273
Tofta	2016-04-20	2021-10-27	PAPPER.KARTONG	6.102	13.22	7	1.358	1.483	18	-0.4949	0.2114
Tofta	2016-04-20	2021-10-27	TRA	4.287	9.167	4.5	1.378	0.8237	18	-0.3983	0.2711
Tofta	2016-04-20	2021-10-27	ORGANISKT	3.345	6.833	3	1.657	1.483	18	0	0.3504
Tofta	2016-04-20	2021-10-27	SANITET.MEDICINSKT	2.814	5.556	3	1.218	1.483	18	0.3327	0.3230
Tofta	2016-04-20	2021-10-27	GLAS.KERAMIK	2.242	3.5	2.5	0.8942	1.483	18	-0.6098	0.0673
Tofta	2016-04-20	2021-10-27	FISH	1.822	1.5	1.5	1.079	1.483	18	0	0.8117

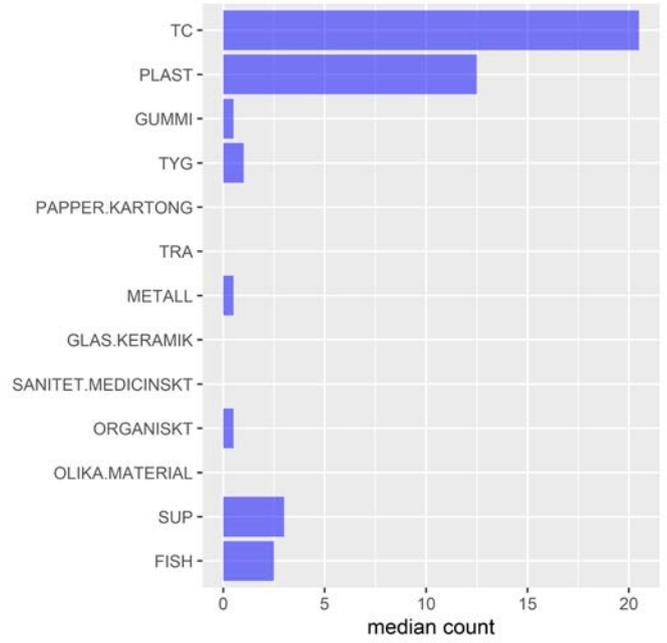
location_code	from	to	group_code	%TC	mean	median	cv	rmad	n	slope	p-value
Tofta	2016-04-20	2021-10-27	GUMMI	1.48	3.056	3	0.9752	0.9884	18	0.3323	0.1670
Tofta	2016-04-20	2021-10-27	TYG	1.304	2.722	1.5	1.022	1.483	18	-0.6702	0.0291
Tofta	2016-04-20	2021-10-27	OLIKA.MATERIAL	0.6578	1.833	0	3.359	NA	18	0	0.1196

The figures below show for each location code the median count for each group.

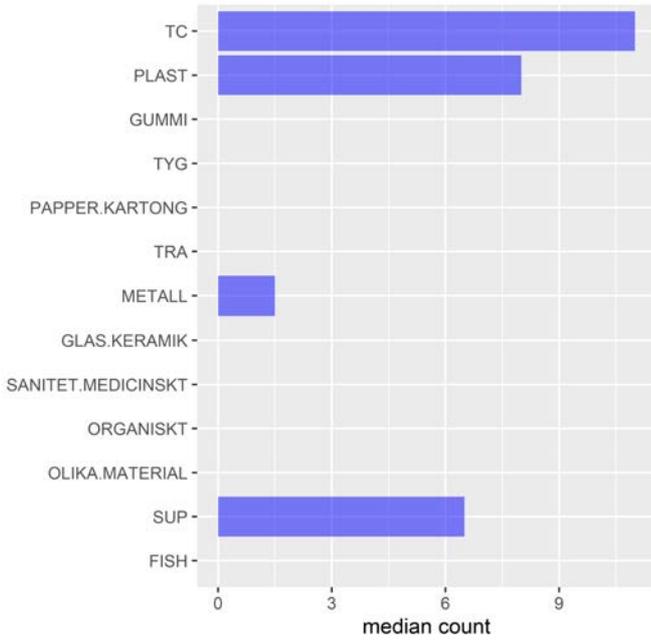
Karehamn



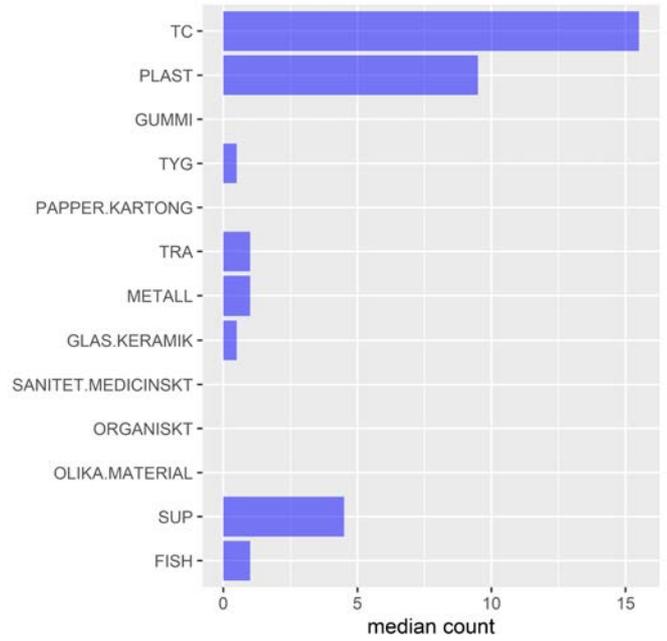
Malarhusen



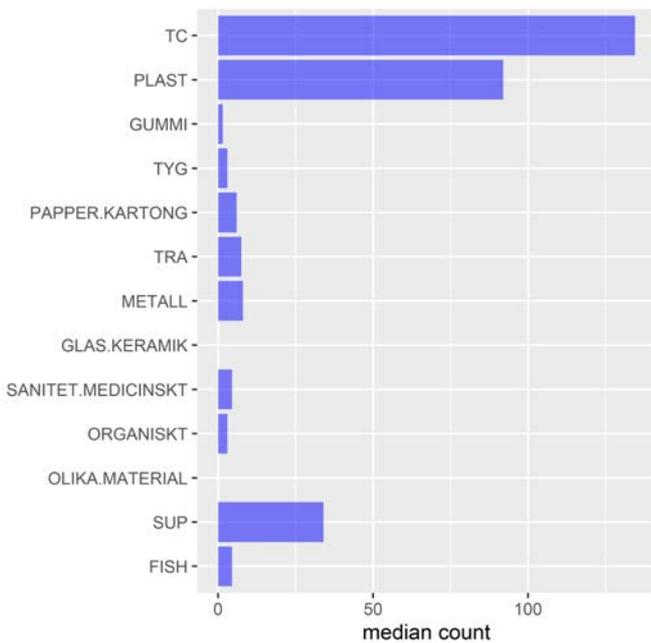
Nattaro



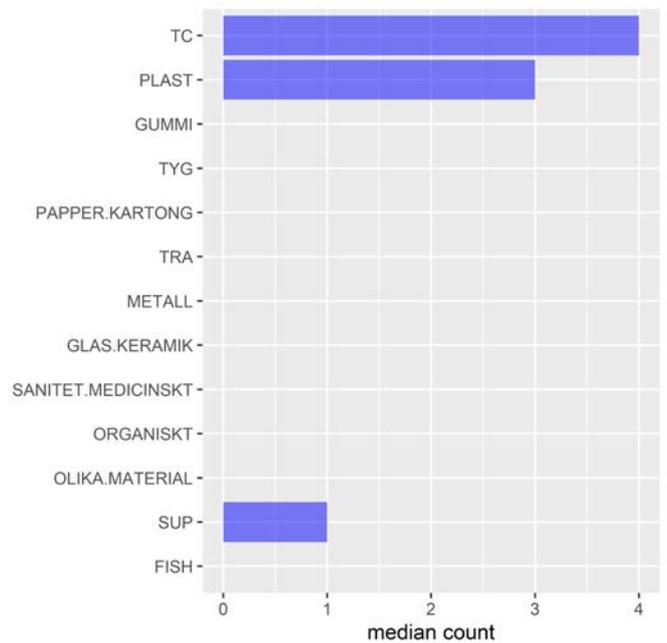
Nybrostrand

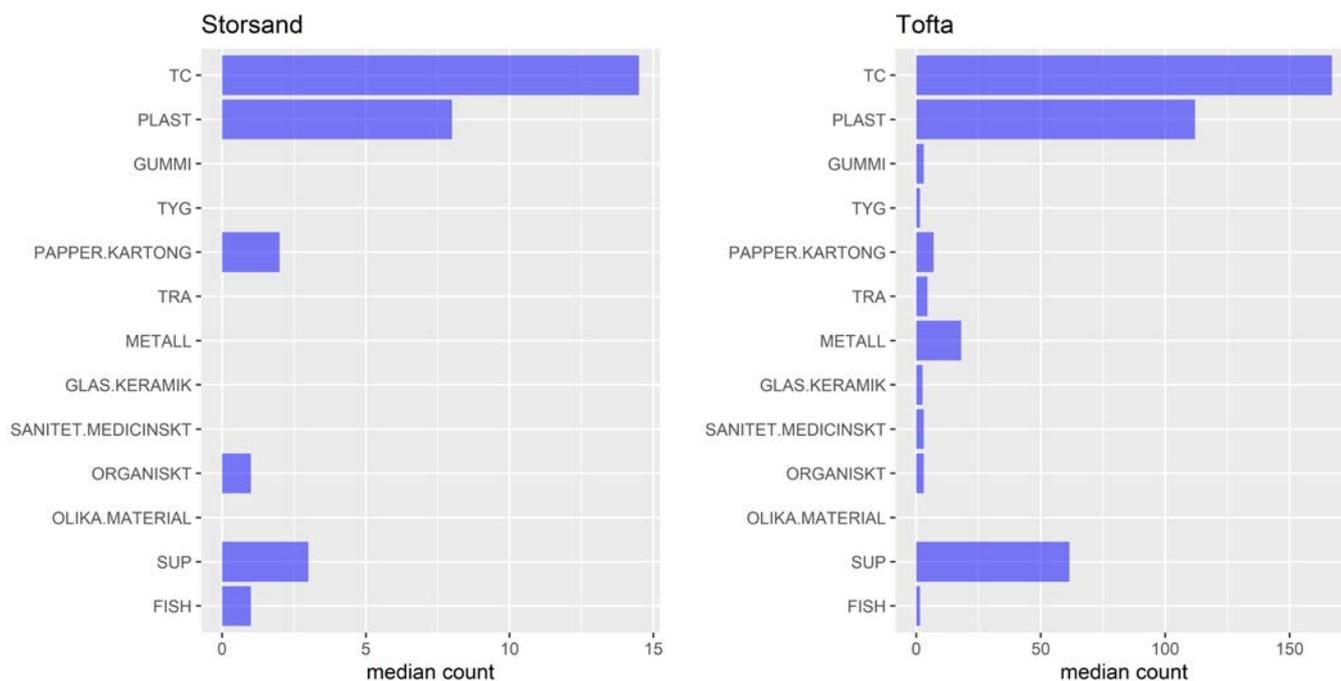


Rullsand



Sjauster





Top 10

The table below gives for each location the top 10 of litter types, *i.e.*, the 10 litter types with the highest median litter counts.

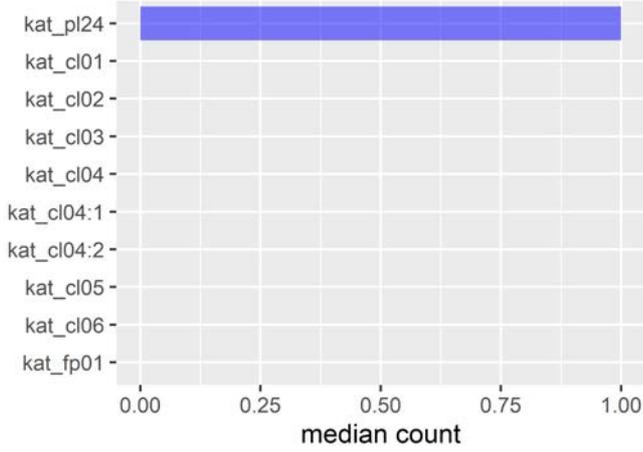
location_code	rank	type_name	median count
Karehamn	1	kat_pl24	1.0
Karehamn	2	kat_cl01	0.0
Karehamn	3	kat_cl02	0.0
Karehamn	4	kat_cl03	0.0
Karehamn	5	kat_cl04	0.0
Karehamn	6	kat_cl04:1	0.0
Karehamn	7	kat_cl04:2	0.0
Karehamn	8	kat_cl05	0.0
Karehamn	9	kat_cl06	0.0
Karehamn	10	kat_fp01	0.0
Malarhusen	1	kat_pl24	2.0
Malarhusen	2	kat_cl06	1.0
Malarhusen	3	kat_pl01	1.0
Malarhusen	4	kat_pl18	1.0
Malarhusen	5	kat_cl01	0.0
Malarhusen	6	kat_cl02	0.0
Malarhusen	7	kat_cl03	0.0
Malarhusen	8	kat_cl04	0.0

location_code	rank	type_name	median count
Malarhusen	9	kat_cl04:1	0.0
Malarhusen	10	kat_cl04:2	0.0
Nattaro	1	kat_me03	1.0
Nattaro	2	kat_cl01	0.0
Nattaro	3	kat_cl02	0.0
Nattaro	4	kat_cl03	0.0
Nattaro	5	kat_cl04	0.0
Nattaro	6	kat_cl04:1	0.0
Nattaro	7	kat_cl04:2	0.0
Nattaro	8	kat_cl05	0.0
Nattaro	9	kat_cl06	0.0
Nattaro	10	kat_fp01	0.0
Nybrostrand	1	kat_pl01	1.0
Nybrostrand	2	kat_pl04	1.0
Nybrostrand	3	kat_cl01	0.0
Nybrostrand	4	kat_cl02	0.0
Nybrostrand	5	kat_cl03	0.0
Nybrostrand	6	kat_cl04	0.0
Nybrostrand	7	kat_cl04:1	0.0
Nybrostrand	8	kat_cl04:2	0.0
Nybrostrand	9	kat_cl05	0.0
Nybrostrand	10	kat_cl06	0.0
Rullsand	1	kat_pl24	18.5
Rullsand	2	kat_pl06	7.5
Rullsand	3	kat_wd03	6.5
Rullsand	4	kat_pc01	4.5
Rullsand	5	kat_pl04	3.0
Rullsand	6	kat_me02	2.5
Rullsand	7	kat_pl01	2.5
Rullsand	8	kat_cl06	2.0
Rullsand	9	kat_or03	2.0
Rullsand	10	kat_pl08	2.0
Sjauster	1	kat_cl01	0.0
Sjauster	2	kat_cl02	0.0
Sjauster	3	kat_cl03	0.0

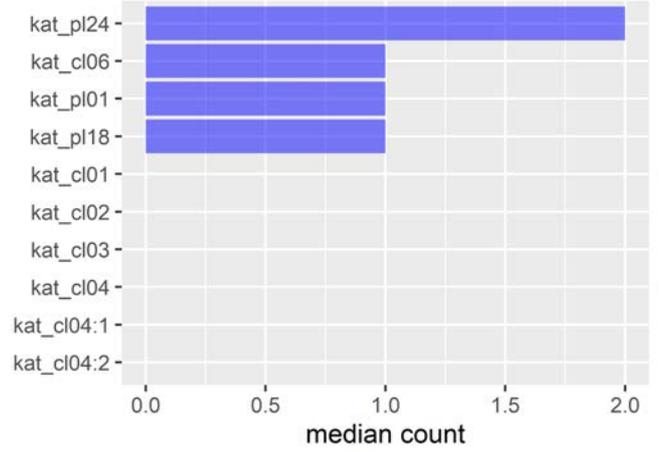
location_code	rank	type_name	median count
Sjauster	4	kat_cl04	0.0
Sjauster	5	kat_cl04:1	0.0
Sjauster	6	kat_cl04:2	0.0
Sjauster	7	kat_cl05	0.0
Sjauster	8	kat_cl06	0.0
Sjauster	9	kat_fp01	0.0
Sjauster	10	kat_fp02	0.0
Storsand	1	kat_or03	1.0
Storsand	2	kat_pl19	0.5
Storsand	3	kat_cl01	0.0
Storsand	4	kat_cl02	0.0
Storsand	5	kat_cl03	0.0
Storsand	6	kat_cl04	0.0
Storsand	7	kat_cl04:1	0.0
Storsand	8	kat_cl04:2	0.0
Storsand	9	kat_cl05	0.0
Storsand	10	kat_cl06	0.0
Tofta	1	kat_pl24	29.0
Tofta	2	kat_pl04	12.0
Tofta	3	kat_me02	10.5
Tofta	4	kat_pl06	7.0
Tofta	5	kat_pl01	4.5
Tofta	6	kat_wd03	4.0
Tofta	7	kat_pl07	3.5
Tofta	8	kat_me06	3.0
Tofta	9	kat_ot02	2.0
Tofta	10	kat_gc07	1.5

The figure(s) below show(s) for each location the top 10 of litter types.

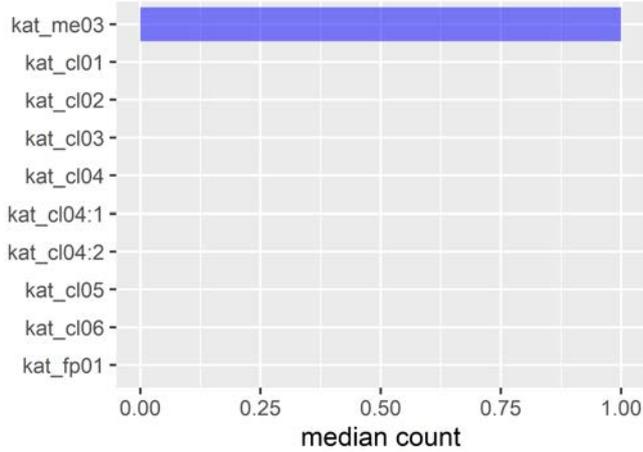
Karehamn



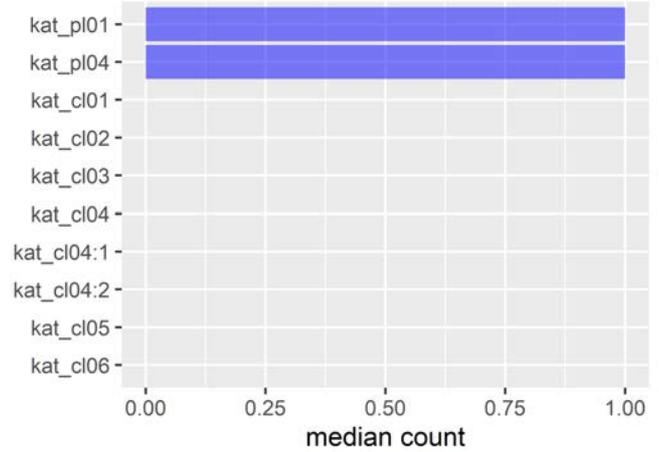
Malarhusen



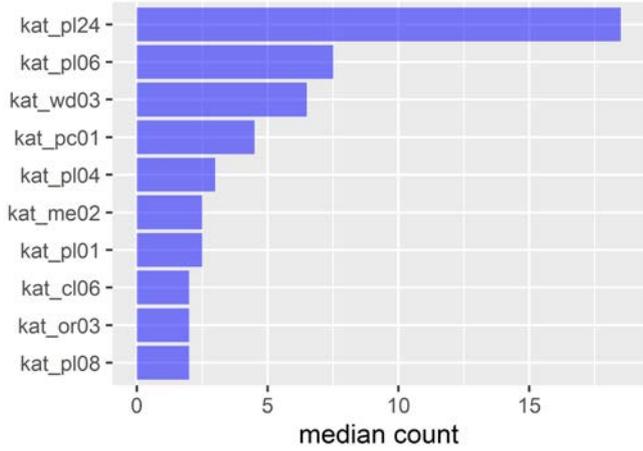
Nattaro



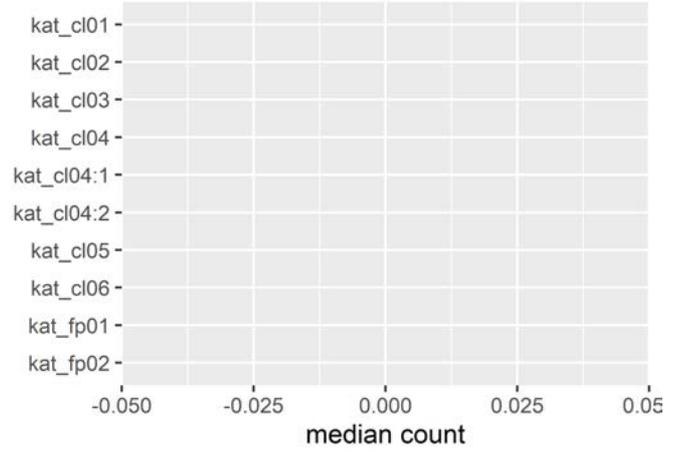
Nybrostrand



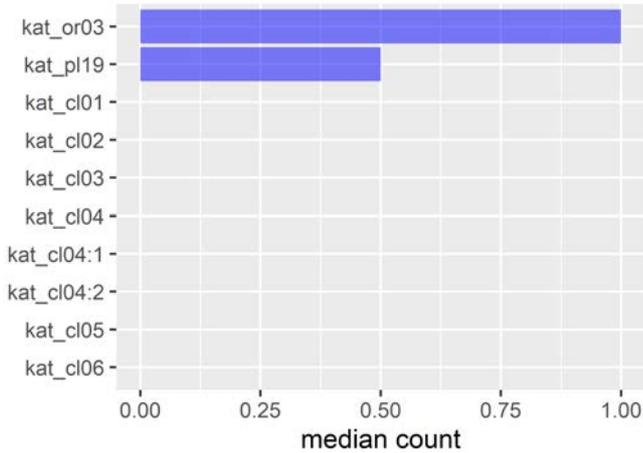
Rullsand



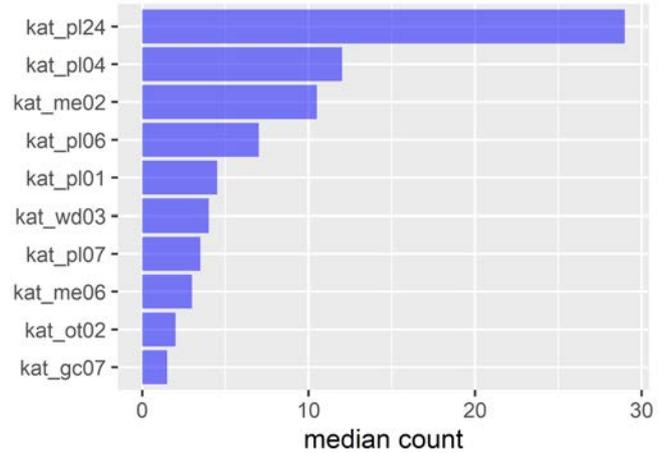
Sjauster



Storsand



Tofta



Regional descriptive statistics

Basic statistics

The regional statistics for the litter groups are given in the table below. They all (except for the p-value) have been estimated in a stepwise fashion:

1. compute the statistic for each individual location within a specific region (see also previous section);
2. compute the same statistic for the results in step 1.

Note that these statistics are all so called intra-block statistics, *i.e.*, data from individual beaches are not merged. Instead, first the beach statistics are calculated and these are then aggregated as described below. Also note that these statistics, in fact, only describe the individual beaches within a region and not necessarily describe the region as a whole statistically correctly.

The statistics are:

- `n` : number of surveys;
- `mean` :, *i.e.*, the regional mean (https://en.wikipedia.org/wiki/Arithmetic_mean) of the individual mean beach counts within a region for each litter group;
- `median` :, *i.e.*, the regional median (<https://en.wikipedia.org/wiki/Median>) of the individual median beach counts within a region for each litter group;
- `slope` : the median of the Theil-Sen slopes of the individual beaches within a region for each litter group. Data from different beaches have not been mixed in the computation of the Theil-Sen slopes. This method is similar to the one in Gilbert (1987) except that in our procedure all beaches within a region contribute equally to the regional trend.
- `p-value` : the p-values for each regional trend (`slope`) are computed by means of the expressions given in Van Belle & Hughes, 1984 (<https://dx.doi.org/10.1029/WR020i001p00127>) (Eqs. 2 and 7) and Gilbert, 1987 (<https://www.osti.gov/biblio/7037501-statistical-methods-environmental-pollution-monitoring>) (Eqs. 17.1 - 17.5).

The trend statistics can only be computed if all `location_code` s of a `region_code` have at least three records (surveys). If that is not the case, the table below contains `NA` .

<code>region_code</code>	<code>group_code</code>	<code>n</code>	<code>mean</code>	<code>median</code>	<code>slope</code>	<code>p-value</code>
OS	TC	144	53.28	15	-0.02787	0.5000
OS	PLAST	144	35.02	8.75	0.2873	0.1499
OS	SUP	144	16.28	3.75	0	0.4347
OS	FISH	144	2.028	1	0	0.2947
OS	METALL	144	4.764	0.75	0	0.0489
OS	ORGANISKT	144	2.792	0.25	0	0.9503
OS	TRA	144	2.833	0.25	0	0.0063
OS	TYG	144	1.458	0.25	0	0.4940
OS	GLAS.KERAMIK	144	0.7778	0	0	0.0216
OS	GUMMI	144	1.104	0	0	0.9473
OS	OLIKA.MATERIAL	144	0.3819	0	0	0.0018

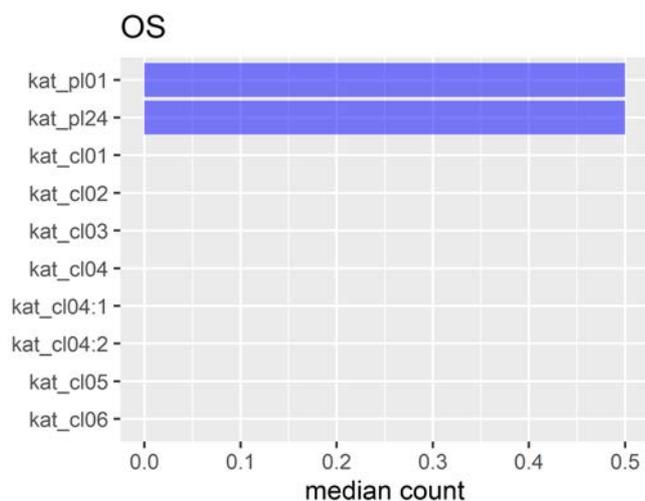
region_code	group_code	n	mean	median	slope	p-value
OS	PAPPER.KARTONG	144	4.153	0	0	0.4035
OS	SANITET.MEDICINSKT	144	1.771	0	0	0.9963

Top 10

The table below gives for each region the top 10 of litter types, *i.e.*, the 10 litter types with the highest median litter counts.

region_code	rank	type_name	median count
OS	1	kat_pl01	0.5
OS	2	kat_pl24	0.5
OS	3	kat_cl01	0.0
OS	4	kat_cl02	0.0
OS	5	kat_cl03	0.0
OS	6	kat_cl04	0.0
OS	7	kat_cl04:1	0.0
OS	8	kat_cl04:2	0.0
OS	9	kat_cl05	0.0
OS	10	kat_cl06	0.0

The figure(s) below show(s) for each region the top 10 of litter types.



Trend analysis

For each location code and the type names and group codes specified in the settings file, the following statistics have been estimated for the period 2016-01-01 to 2021-12-31:

- from: the first date of the time-series;
- to: the final date of the time-series;
- Theil-Sen slope (https://en.wikipedia.org/wiki/Theil%E2%80%93Sen_estimator) (slope): a robust non-parametric estimator of slope (counts / year);
- p-value (<https://en.wikipedia.org/wiki/P-value>): the p-value associated with the one-tailed Mann-Kendall test (https://en.wikipedia.org/wiki/Kendall_rank_correlation_coefficient) to test the null hypothesis of
 - no monotonically *increasing* trend in case the Theil-Sen slope is greater than zero;
 - no monotonically *decreasing* trend in case the Theil-Sen slope is smaller than zero;
- the number of surveys (N);

A p-value less than an *a priori* specified significance level (https://en.wikipedia.org/wiki/Statistical_significance) (e.g., often $\alpha = 0.05$), indicates a significant trend. If the p-value is greater than this significance level, we can't say that there is no trend. We can only conclude that our data do not show evidence for a significant trend (due to lack of data, noise, etc.).

The Mann-Kendall test is a non-parametric test and as such does not make distributional assumptions on the data.

Warning: The following specified group code(s) are not found and will be skipped:
'KEMISKA.FORORENINGAR'

location_code	type name / group code	from	to	N	slope	p-value
Karehamn	TC	2016-04-22	2021-10-27	18	0.2497	0.2969
Karehamn	FISH	2016-04-22	2021-10-27	18	0	0.6815
Karehamn	GLAS.KERAMIK	2016-04-22	2021-10-27	18	0	0.6825
Karehamn	GUMMI	2016-04-22	2021-10-27	18	0	0.8922
Karehamn	METALL	2016-04-22	2021-10-27	18	0	0.8899
Karehamn	OLIKA.MATERIAL	2016-04-22	2021-10-27	18	0	NA
Karehamn	ORGANISKT	2016-04-22	2021-10-27	18	0	0.5628
Karehamn	PAPPER.KARTONG	2016-04-22	2021-10-27	18	0	0.4298
Karehamn	PLAST	2016-04-22	2021-10-27	18	0	0.5758
Karehamn	SANITET.MEDICINSKT	2016-04-22	2021-10-27	18	0	NA
Karehamn	SUP	2016-04-22	2021-10-27	18	0	0.1860
Karehamn	TRA	2016-04-22	2021-10-27	18	0	0.0415
Karehamn	TYG	2016-04-22	2021-10-27	18	0	0.3182
Malarhusen	PLAST	2016-04-18	2021-11-07	18	2.609	0.0798
Malarhusen	TC	2016-04-18	2021-11-07	18	1.494	0.3110
Malarhusen	SUP	2016-04-18	2021-11-07	18	0.1901	0.2697
Malarhusen	FISH	2016-04-18	2021-11-07	18	0	0.7057
Malarhusen	GLAS.KERAMIK	2016-04-18	2021-11-07	18	0	0.1221
Malarhusen	GUMMI	2016-04-18	2021-11-07	18	0	0.9197
Malarhusen	METALL	2016-04-18	2021-11-07	18	0	0.2541
Malarhusen	OLIKA.MATERIAL	2016-04-18	2021-11-07	18	0	0.0258
Malarhusen	ORGANISKT	2016-04-18	2021-11-07	18	0	0.6876

location_code	type name / group code	from	to	N	slope	p-value
Malarhusen	PAPPER.KARTONG	2016-04-18	2021-11-07	18	0	0.6690
Malarhusen	SANITET.MEDICINSKT	2016-04-18	2021-11-07	18	0	0.8758
Malarhusen	TRA	2016-04-18	2021-11-07	18	0	0.7080
Malarhusen	TYG	2016-04-18	2021-11-07	18	0	0.7313
Nattaro	TC	2016-04-28	2021-10-28	18	1.148	0.0856
Nattaro	PLAST	2016-04-28	2021-10-28	18	1.023	0.0509
Nattaro	SUP	2016-04-28	2021-10-28	18	0.998	0.0957
Nattaro	FISH	2016-04-28	2021-10-28	18	0	0.0934
Nattaro	GLAS.KERAMIK	2016-04-28	2021-10-28	18	0	0.3765
Nattaro	GUMMI	2016-04-28	2021-10-28	18	0	0.1928
Nattaro	METALL	2016-04-28	2021-10-28	18	0	0.6383
Nattaro	OLIKA.MATERIAL	2016-04-28	2021-10-28	18	0	NA
Nattaro	ORGANISKT	2016-04-28	2021-10-28	18	0	0.5955
Nattaro	PAPPER.KARTONG	2016-04-28	2021-10-28	18	0	0.4582
Nattaro	SANITET.MEDICINSKT	2016-04-28	2021-10-28	18	0	0.8673
Nattaro	TRA	2016-04-28	2021-10-28	18	0	0.1035
Nattaro	TYG	2016-04-28	2021-10-28	18	0	0.6928
Nybrostrand	TC	2016-05-03	2021-10-23	18	-4.132	0.0084
Nybrostrand	PLAST	2016-05-03	2021-10-23	18	-2.474	0.0264
Nybrostrand	SUP	2016-05-03	2021-10-23	18	-0.8844	0.0237
Nybrostrand	METALL	2016-05-03	2021-10-23	18	-0.5159	0.0073
Nybrostrand	FISH	2016-05-03	2021-10-23	18	-0.3823	0.0022
Nybrostrand	GLAS.KERAMIK	2016-05-03	2021-10-23	18	0	0.0187
Nybrostrand	GUMMI	2016-05-03	2021-10-23	18	0	0.0186
Nybrostrand	OLIKA.MATERIAL	2016-05-03	2021-10-23	18	0	0.1445
Nybrostrand	ORGANISKT	2016-05-03	2021-10-23	18	0	0.3841
Nybrostrand	PAPPER.KARTONG	2016-05-03	2021-10-23	18	0	0.0857
Nybrostrand	SANITET.MEDICINSKT	2016-05-03	2021-10-23	18	0	0.8430
Nybrostrand	TRA	2016-05-03	2021-10-23	18	0	0.0927
Nybrostrand	TYG	2016-05-03	2021-10-23	18	0	0.6296
Rullsand	TC	2016-04-18	2021-10-24	18	20.95	0.0287
Rullsand	PLAST	2016-04-18	2021-10-24	18	15.2	0.0244
Rullsand	SUP	2016-04-18	2021-10-24	18	6.576	0.0477
Rullsand	FISH	2016-04-18	2021-10-24	18	1.623	0.0198
Rullsand	ORGANISKT	2016-04-18	2021-10-24	18	1.269	0.0139

location_code	type name / group code	from	to	N	slope	p-value
Rullsand	PAPPER.KARTONG	2016-04-18	2021-10-24	18	1.252	0.1115
Rullsand	TRA	2016-04-18	2021-10-24	18	1.09	0.0859
Rullsand	SANITET.MEDICINSKT	2016-04-18	2021-10-24	18	0.903	0.0335
Rullsand	GUMMI	2016-04-18	2021-10-24	18	0.8245	0.0074
Rullsand	METALL	2016-04-18	2021-10-24	18	-0.4498	0.2835
Rullsand	TYG	2016-04-18	2021-10-24	18	0.4049	0.1036
Rullsand	GLAS.KERAMIK	2016-04-18	2021-10-24	18	0	0.6881
Rullsand	OLIKA.MATERIAL	2016-04-18	2021-10-24	18	0	0.0338
Sjauster	TC	2016-04-18	2021-10-27	18	-0.3054	0.2321
Sjauster	FISH	2016-04-18	2021-10-27	18	0	0.0507
Sjauster	GLAS.KERAMIK	2016-04-18	2021-10-27	18	0	0.3355
Sjauster	GUMMI	2016-04-18	2021-10-27	18	0	0.7500
Sjauster	METALL	2016-04-18	2021-10-27	18	0	0.0423
Sjauster	OLIKA.MATERIAL	2016-04-18	2021-10-27	18	0	0.2204
Sjauster	ORGANISKT	2016-04-18	2021-10-27	18	0	0.8071
Sjauster	PAPPER.KARTONG	2016-04-18	2021-10-27	18	0	0.9294
Sjauster	PLAST	2016-04-18	2021-10-27	18	0	0.5000
Sjauster	SANITET.MEDICINSKT	2016-04-18	2021-10-27	18	0	0.5235
Sjauster	SUP	2016-04-18	2021-10-27	18	0	0.0787
Sjauster	TRA	2016-04-18	2021-10-27	18	0	0.0535
Sjauster	TYG	2016-04-18	2021-10-27	18	0	0.1252
Storsand	TC	2016-05-18	2021-10-19	18	-0.6659	0.2844
Storsand	PLAST	2016-05-18	2021-10-19	18	-0.5108	0.3241
Storsand	TRA	2016-05-18	2021-10-19	18	-0.4976	0.0008
Storsand	PAPPER.KARTONG	2016-05-18	2021-10-19	18	-0.2279	0.1456
Storsand	FISH	2016-05-18	2021-10-19	18	0	0.2267
Storsand	GLAS.KERAMIK	2016-05-18	2021-10-19	18	0	NA
Storsand	GUMMI	2016-05-18	2021-10-19	18	0	0.7022
Storsand	METALL	2016-05-18	2021-10-19	18	0	0.6601
Storsand	OLIKA.MATERIAL	2016-05-18	2021-10-19	18	0	0.5384
Storsand	ORGANISKT	2016-05-18	2021-10-19	18	0	0.8932
Storsand	SANITET.MEDICINSKT	2016-05-18	2021-10-19	18	0	0.9465
Storsand	SUP	2016-05-18	2021-10-19	18	0	0.6782
Storsand	TYG	2016-05-18	2021-10-19	18	0	0.7855
Tofta	TC	2016-04-20	2021-10-27	18	-7.551	0.2721

location_code	type name / group code	from	to	N	slope	p-value
Tofta	METALL	2016-04-20	2021-10-27	18	-2.786	0.1273
Tofta	SUP	2016-04-20	2021-10-27	18	-0.7454	0.3521
Tofta	TYG	2016-04-20	2021-10-27	18	-0.6702	0.0291
Tofta	GLAS.KERAMIK	2016-04-20	2021-10-27	18	-0.6098	0.0673
Tofta	PLAST	2016-04-20	2021-10-27	18	0.5746	0.4397
Tofta	PAPPER.KARTONG	2016-04-20	2021-10-27	18	-0.4949	0.2114
Tofta	TRA	2016-04-20	2021-10-27	18	-0.3983	0.2711
Tofta	SANITET.MEDICINSKT	2016-04-20	2021-10-27	18	0.3327	0.3230
Tofta	GUMMI	2016-04-20	2021-10-27	18	0.3323	0.1670
Tofta	FISH	2016-04-20	2021-10-27	18	0	0.8117
Tofta	OLIKA.MATERIAL	2016-04-20	2021-10-27	18	0	0.1196
Tofta	ORGANISKT	2016-04-20	2021-10-27	18	0	0.3504

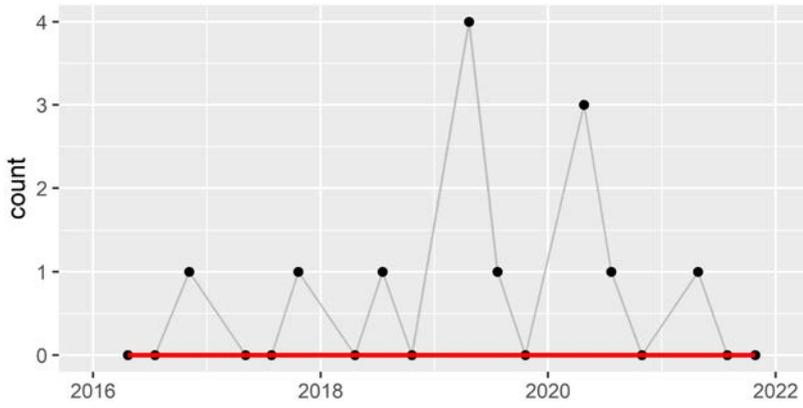
Descriptive statistics and trend analysis results have been stored in file 'litteR-results-20230328T154901.csv'.

Time-series of the selected type names, group codes and and spatial codes are given in the plots below, including trend line and smoother.

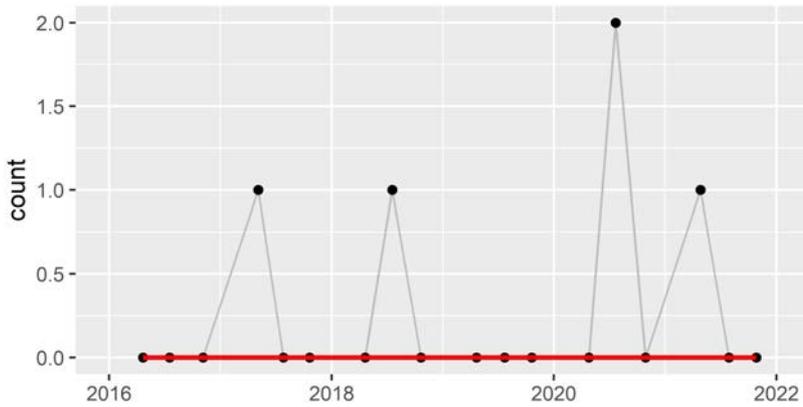
The lines and dots have the following meaning:

- dots: observations;
- thin gray line segments: auxiliary line segments to guide the eye (only given for 5 to 24 points);
- blue line: loess-smoother (https://en.wikipedia.org/wiki/Local_regression). It is only given for 25 or more points;
- red line: Theil-Sen trend line (its slope is given in the table above). It is only given for 5 or more points. However, it is recommended to use a minimum period of 4 to 5 years to obtain useful trend results.

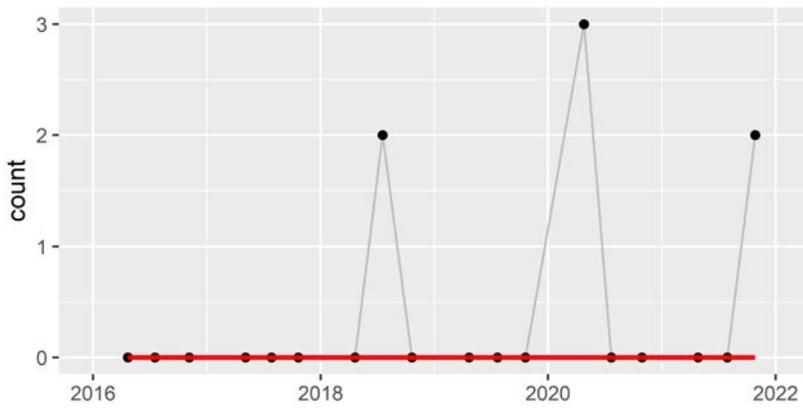
Karehamn FISH



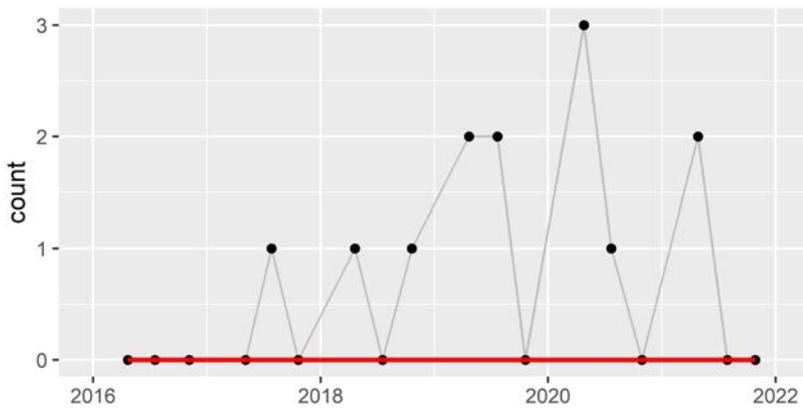
Karehamn GLAS.KERAMIK



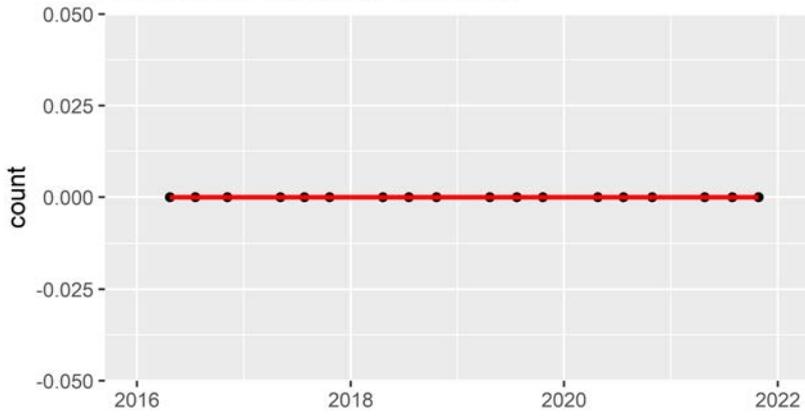
Karehamn GUMMI



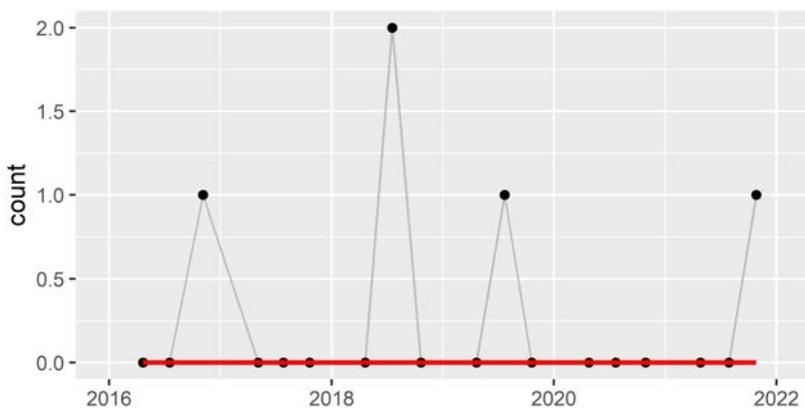
Karehamn METALL



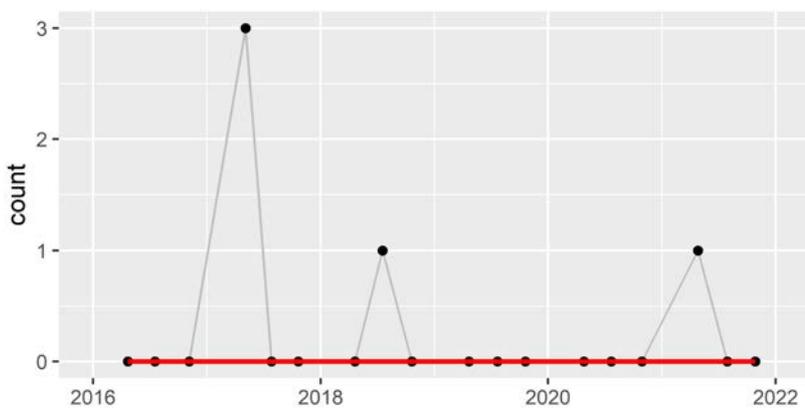
Karehamn OLIKA.MATERIAL



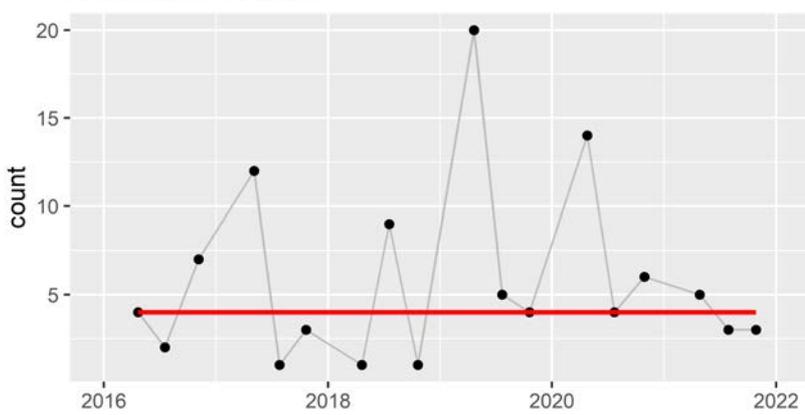
Karehamn ORGANISKT



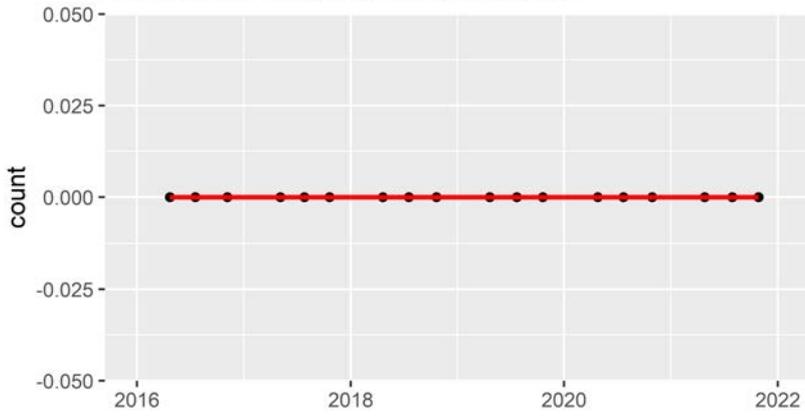
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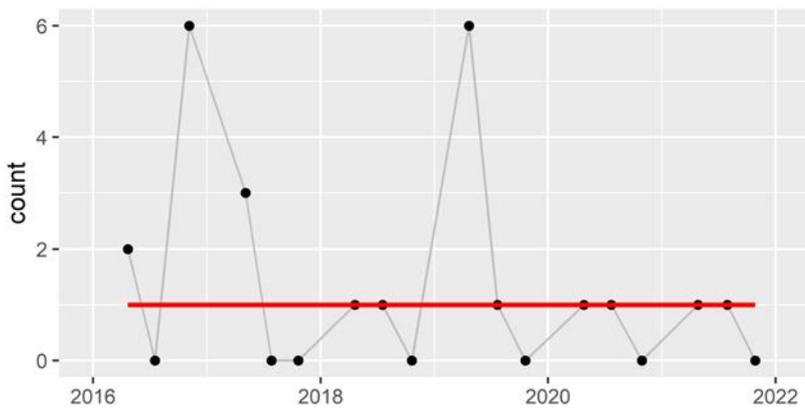
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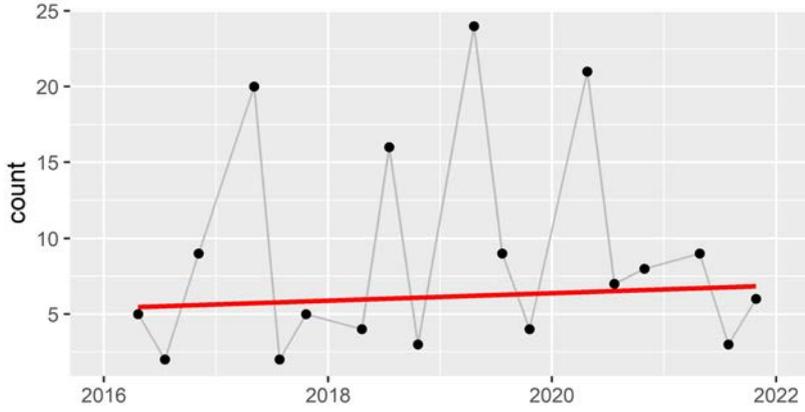
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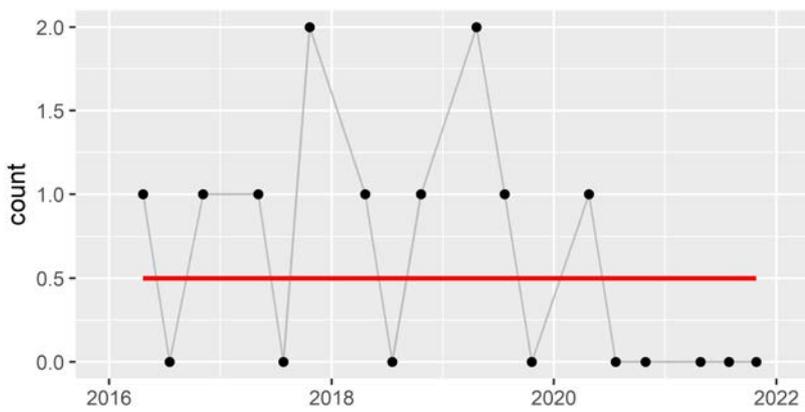
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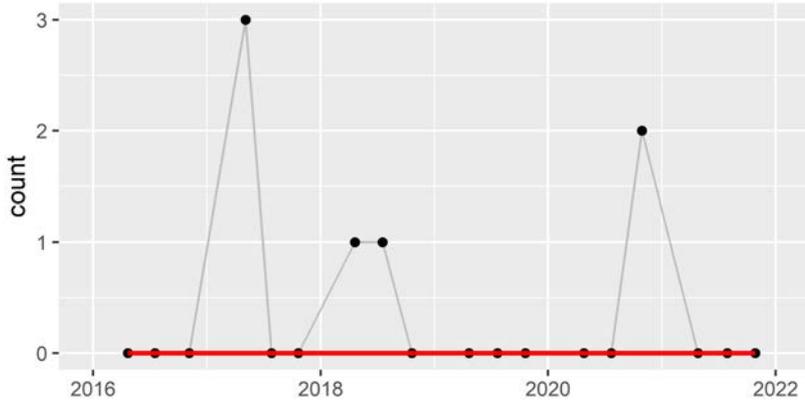
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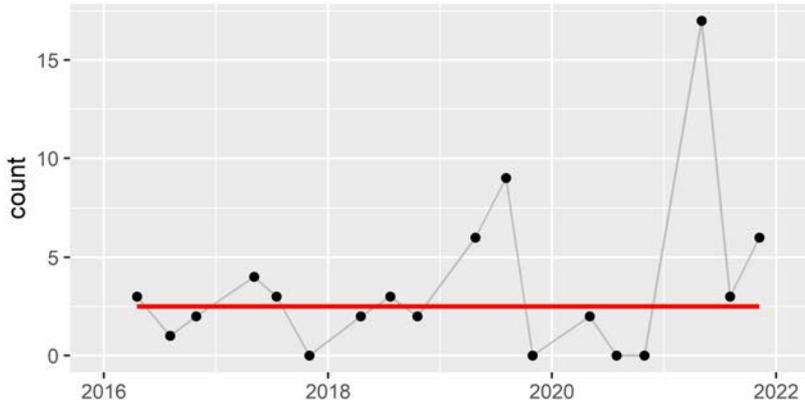
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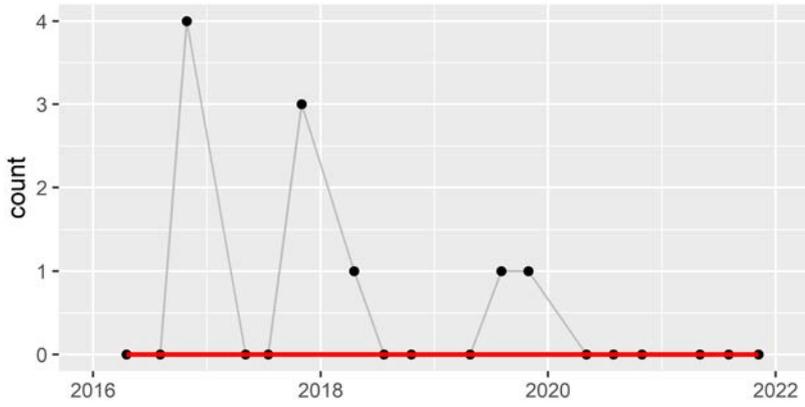
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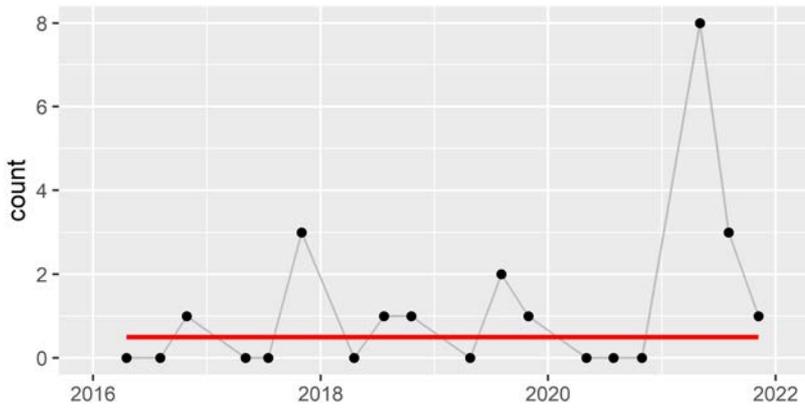
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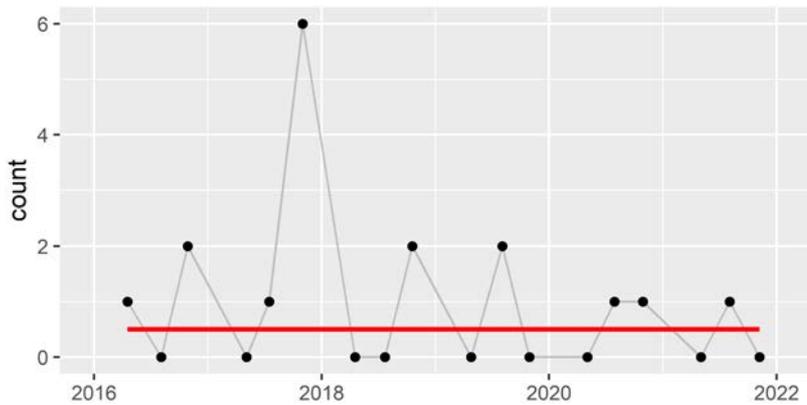
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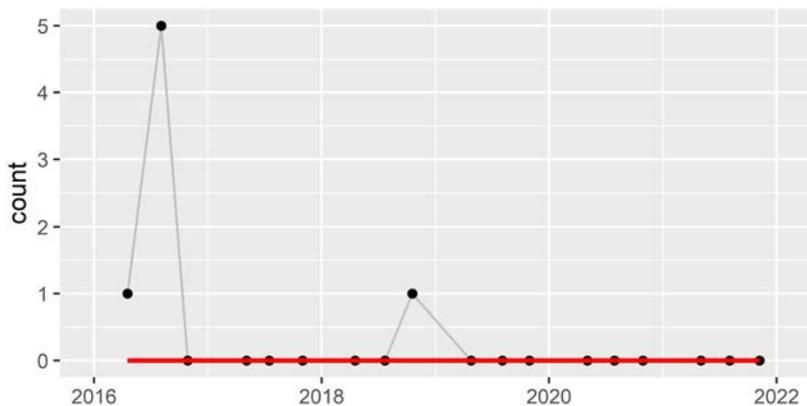
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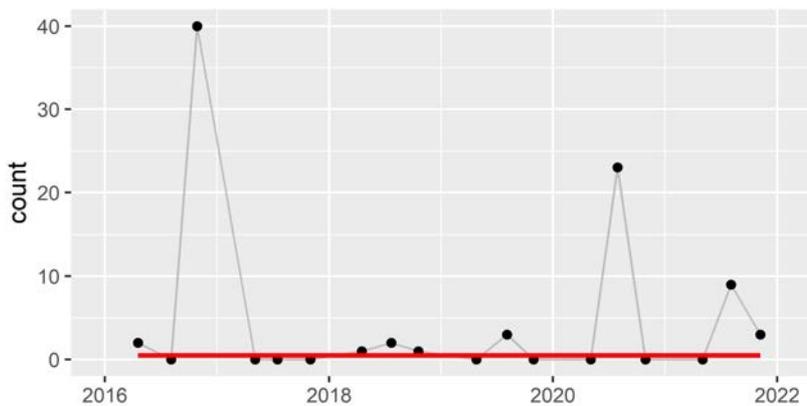
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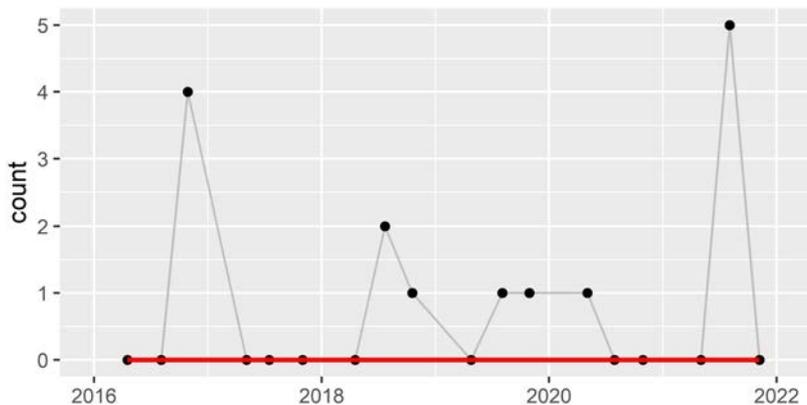
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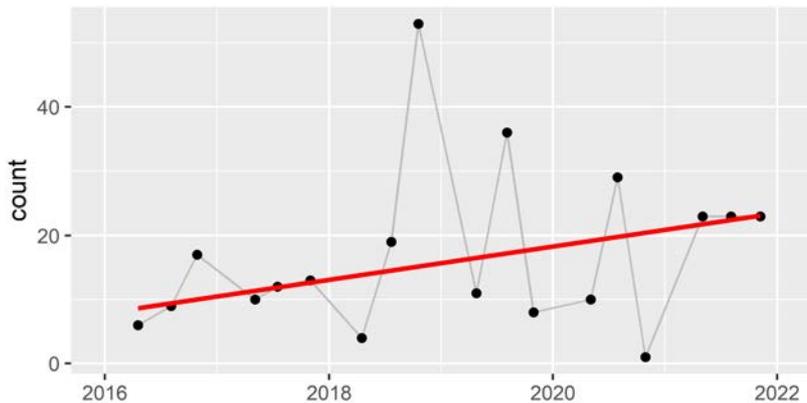
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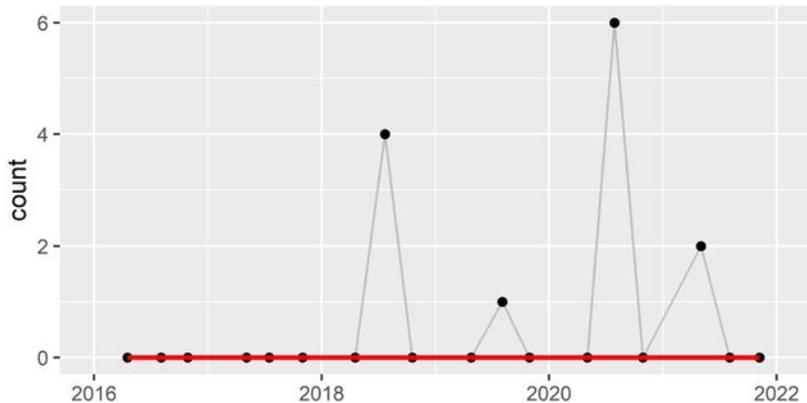
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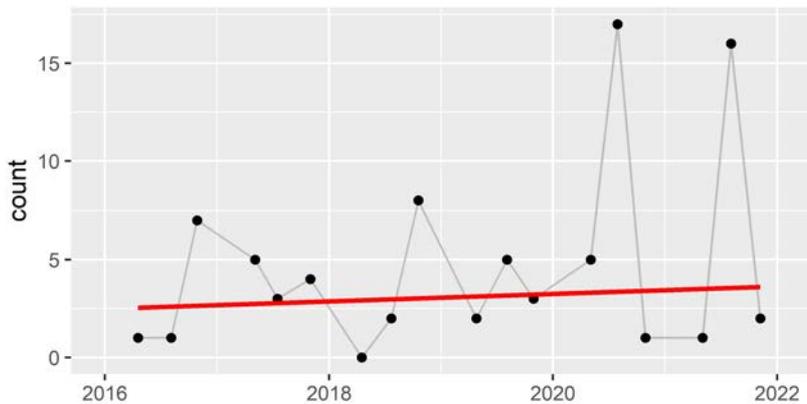
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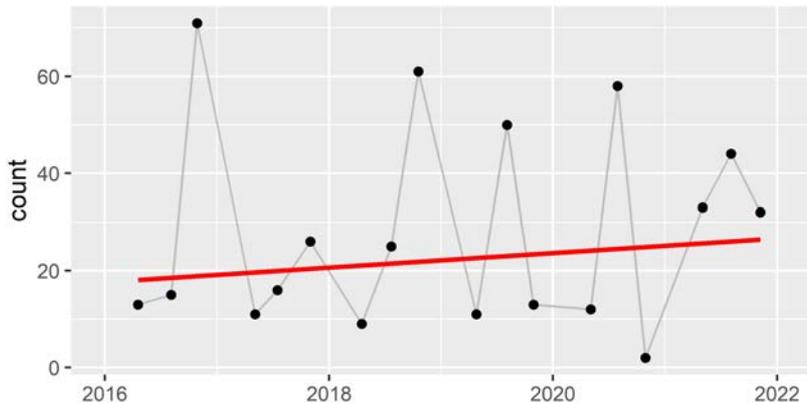
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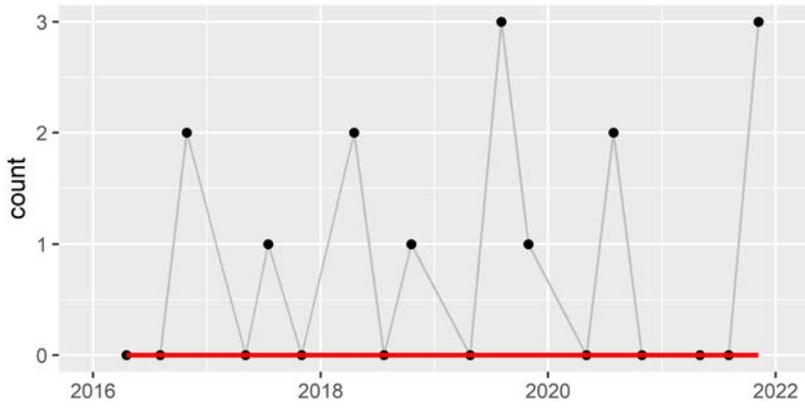
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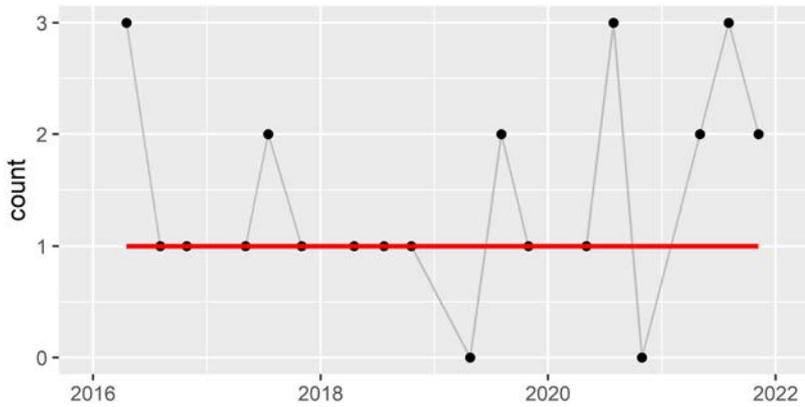
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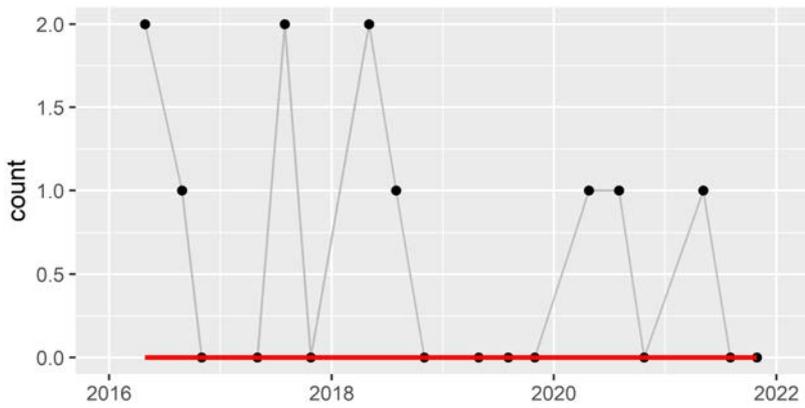
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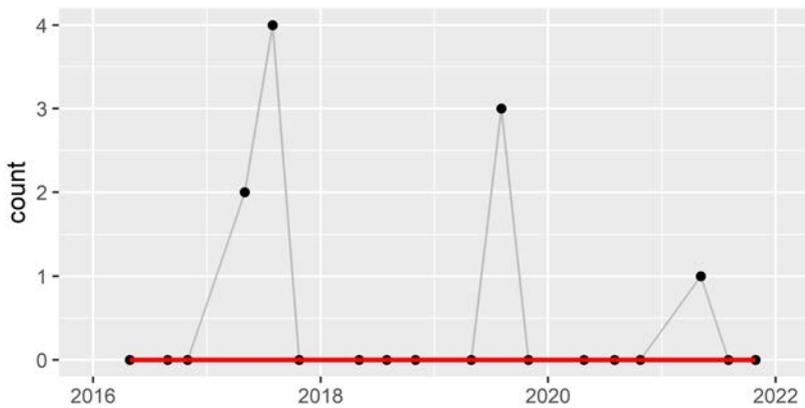
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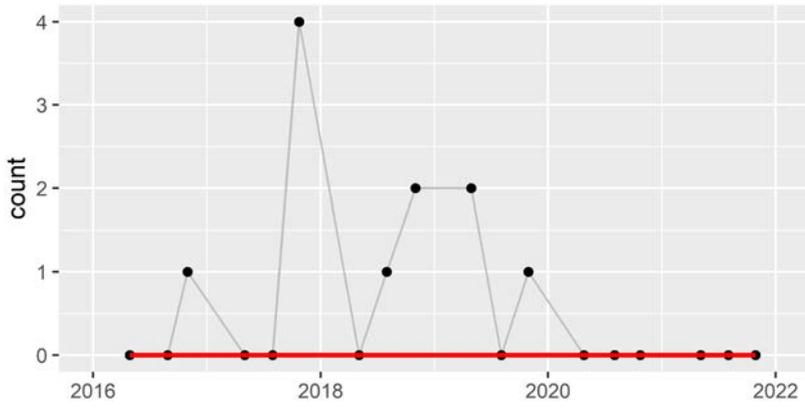
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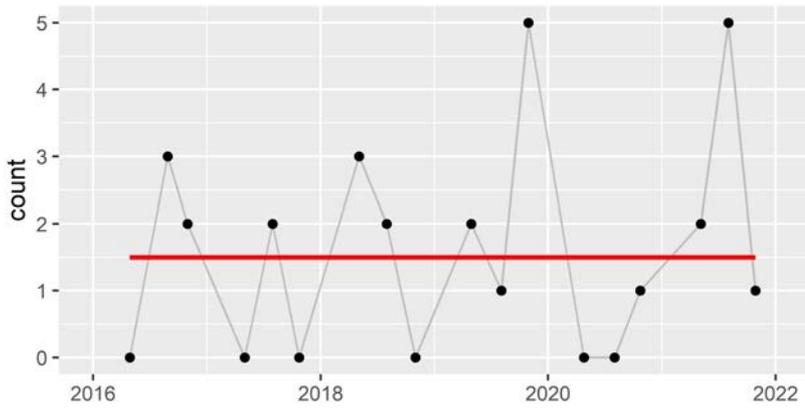
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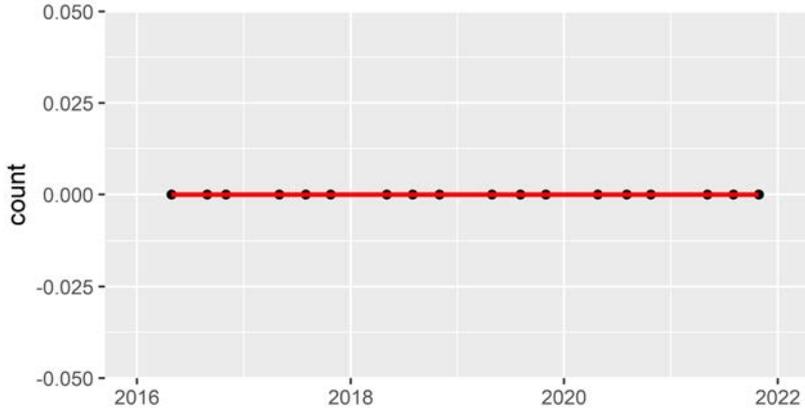
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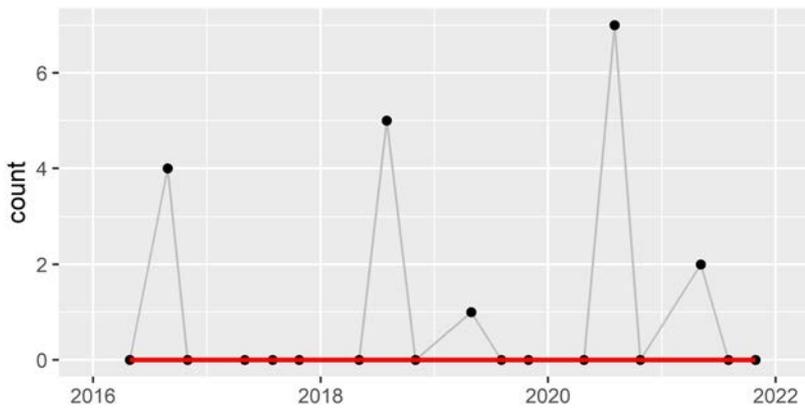
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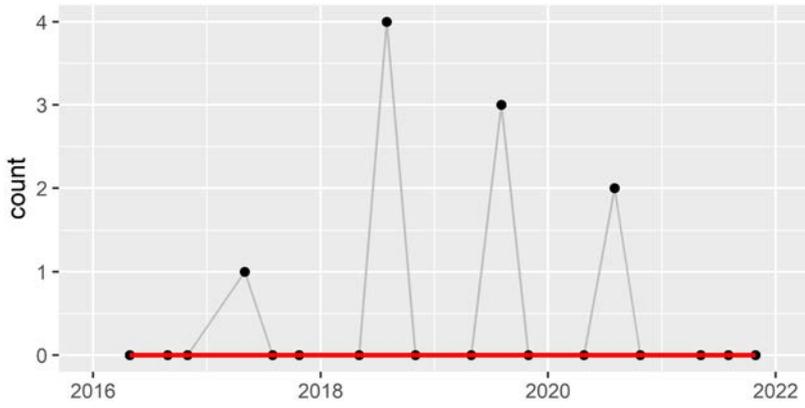
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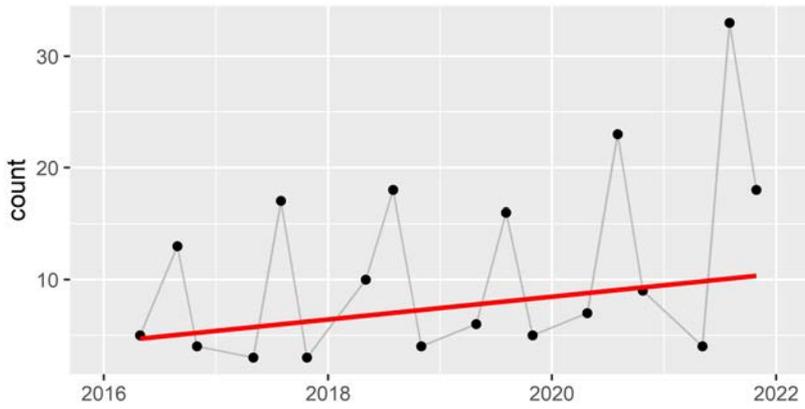
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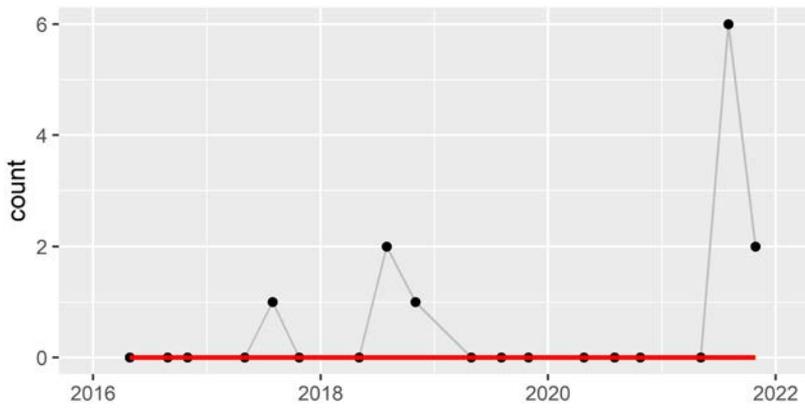
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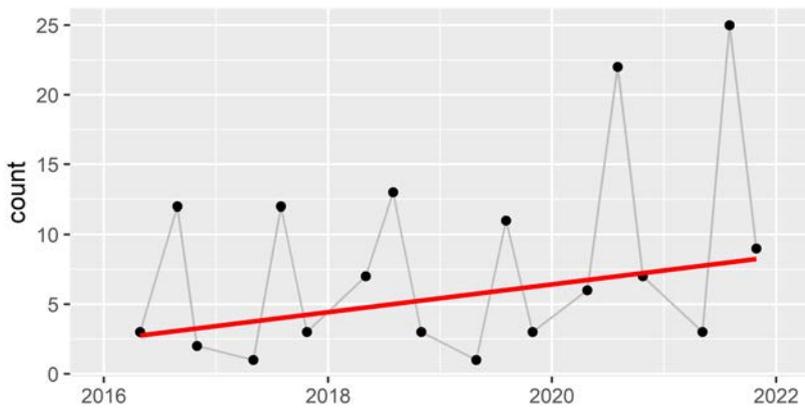
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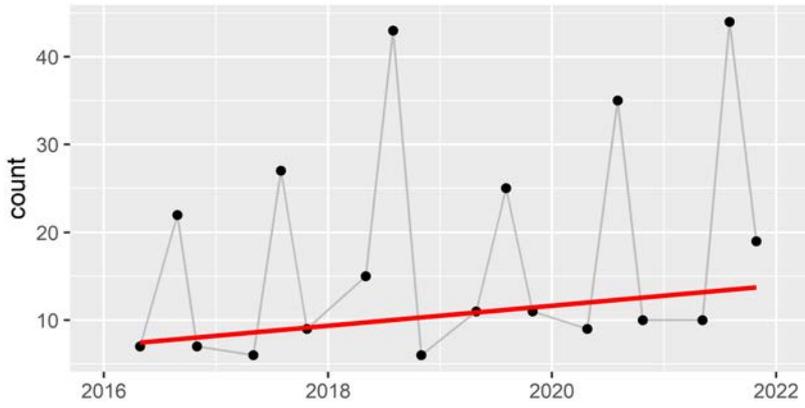
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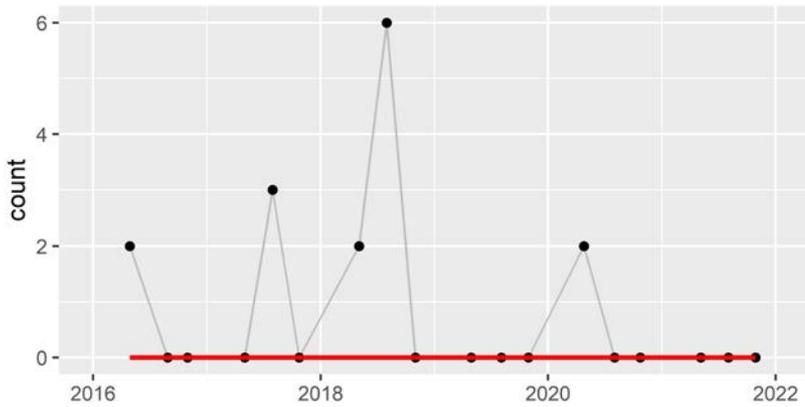
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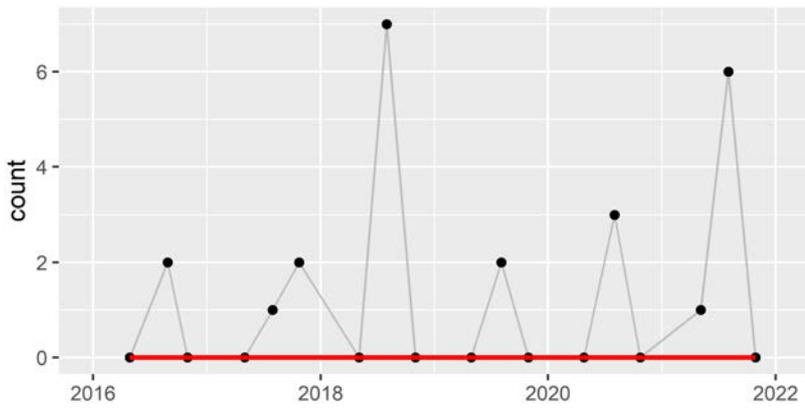
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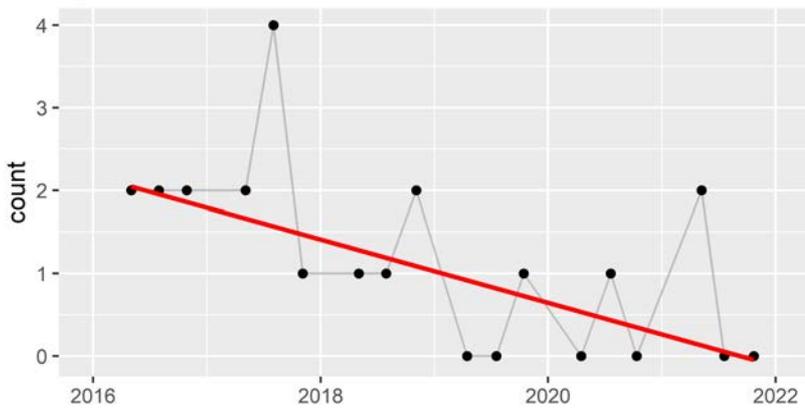
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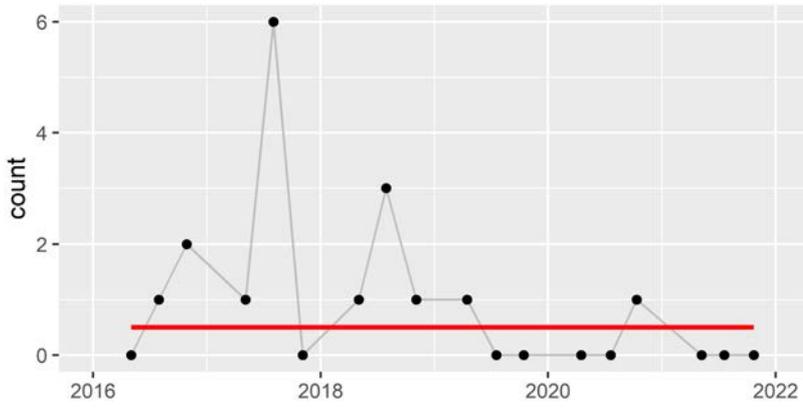
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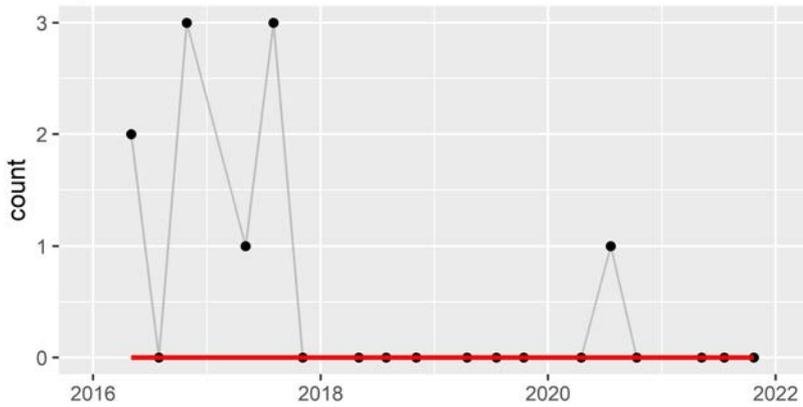
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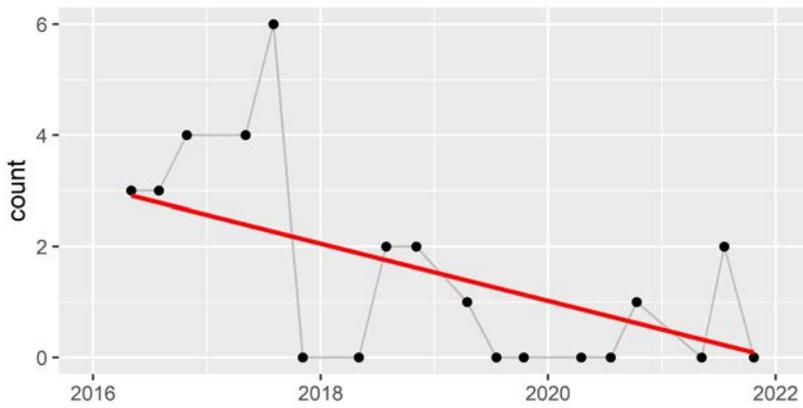
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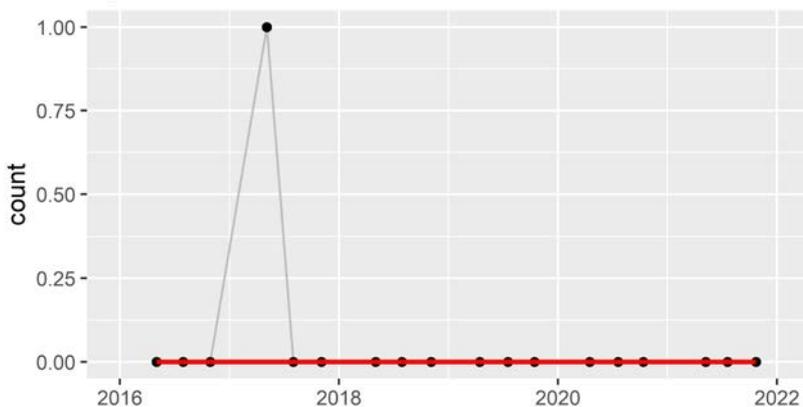
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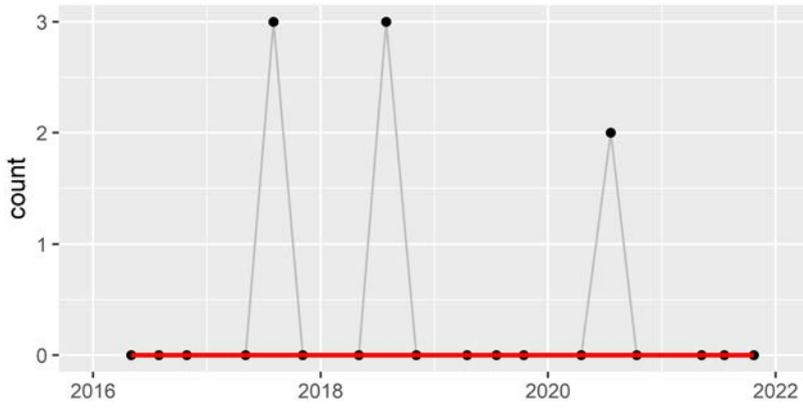
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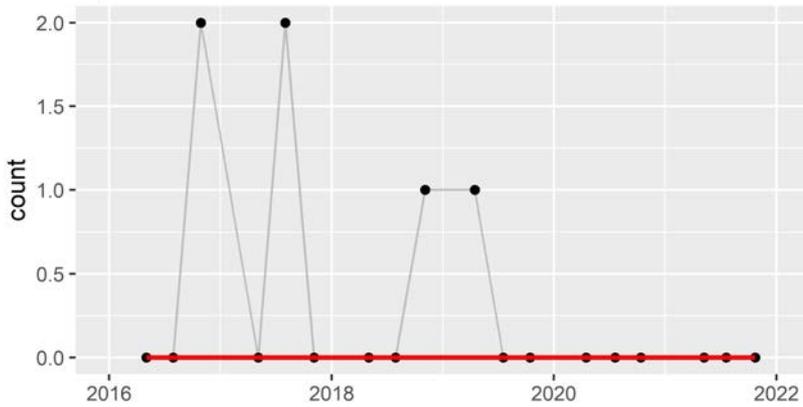
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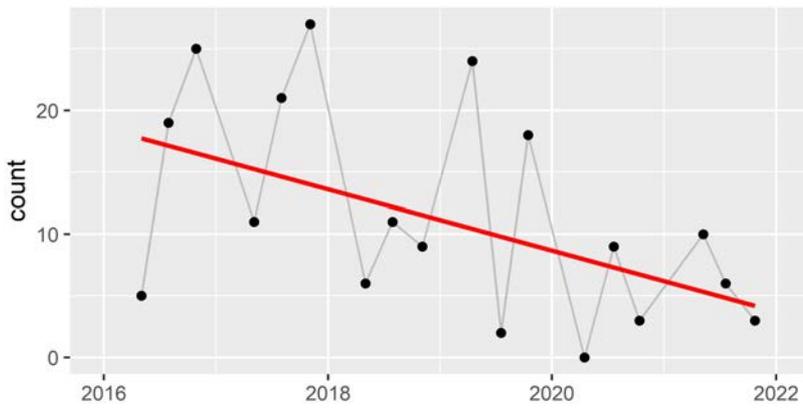
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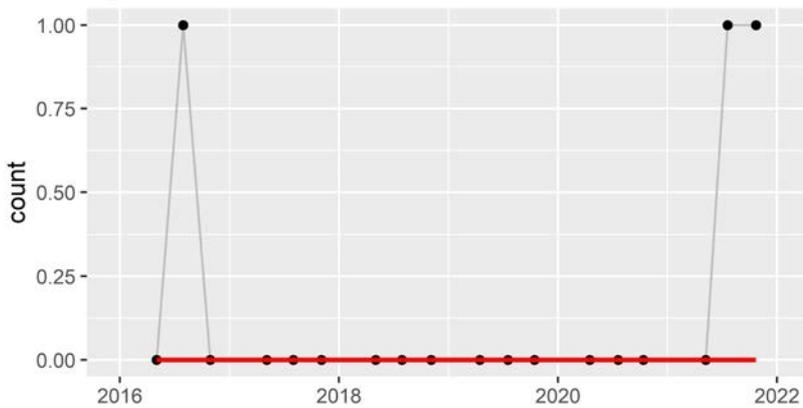
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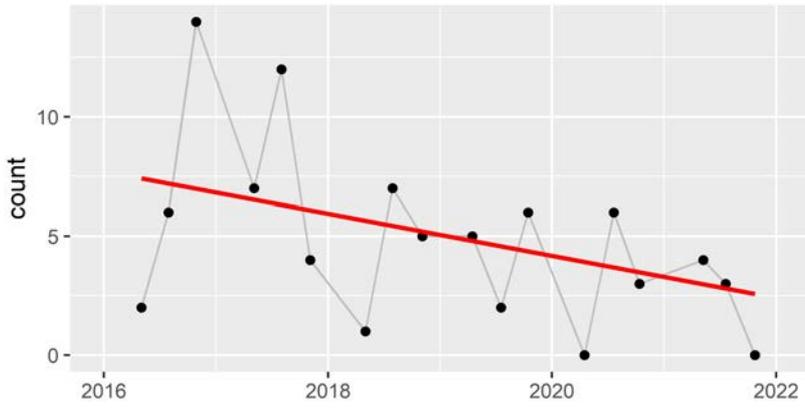
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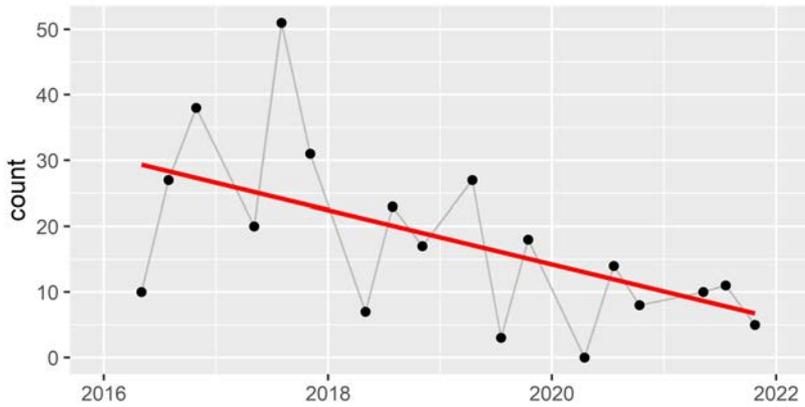
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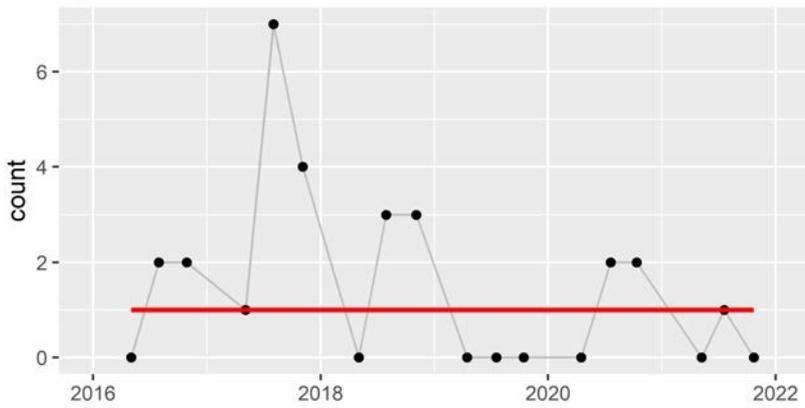
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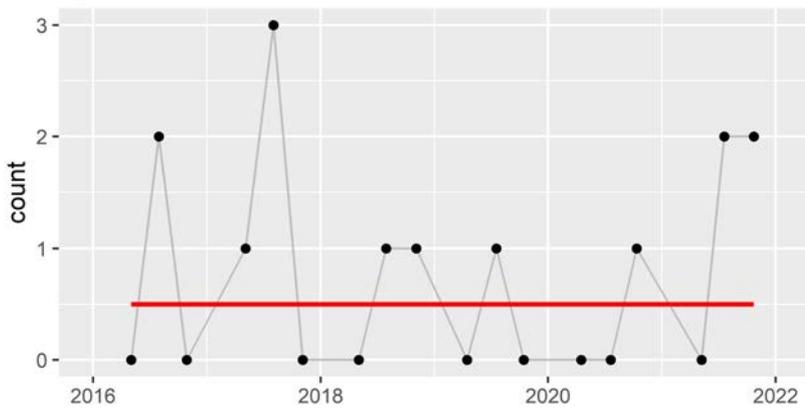
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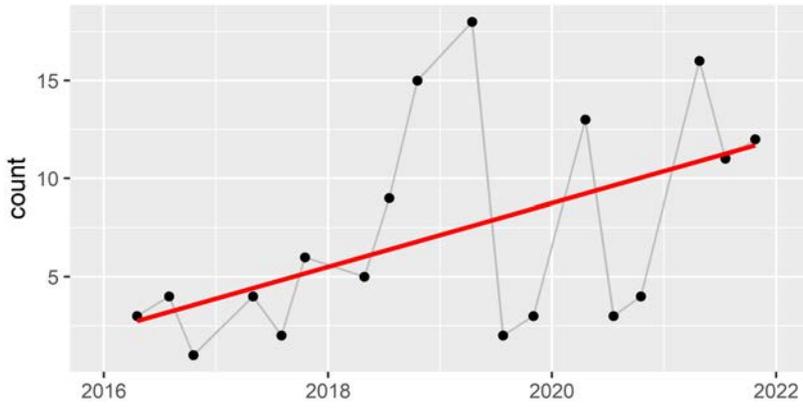
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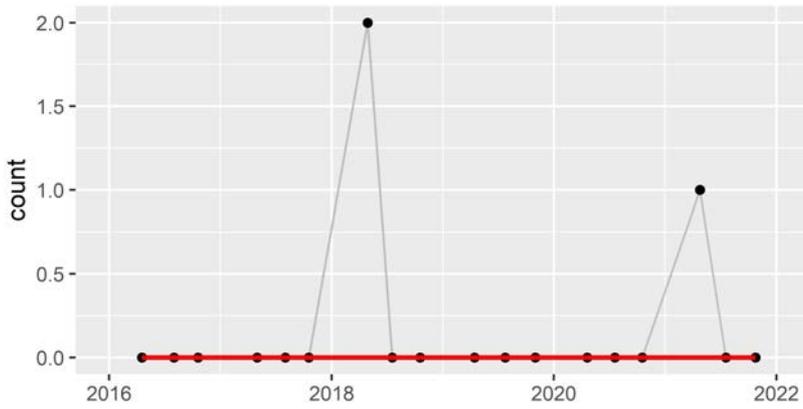
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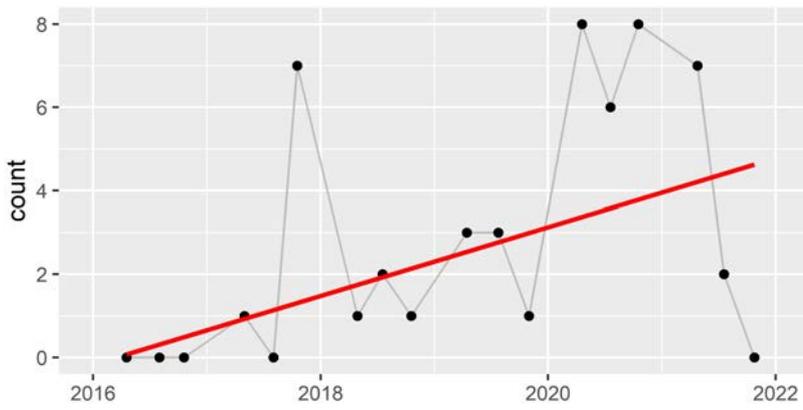
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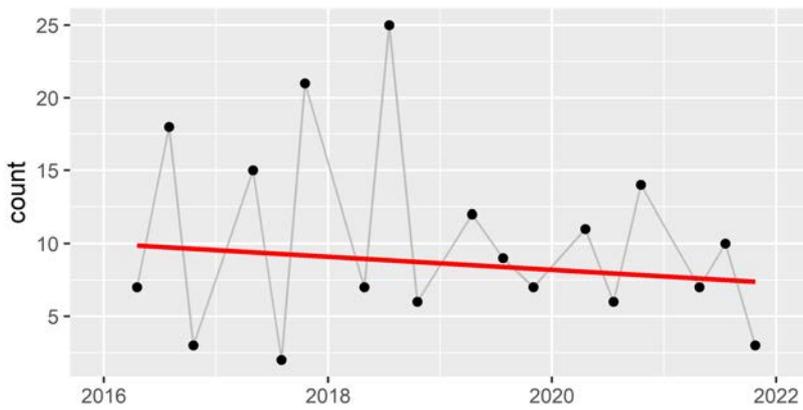
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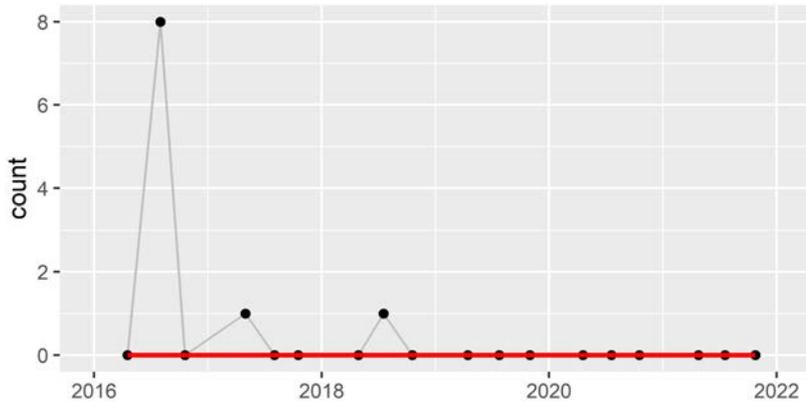
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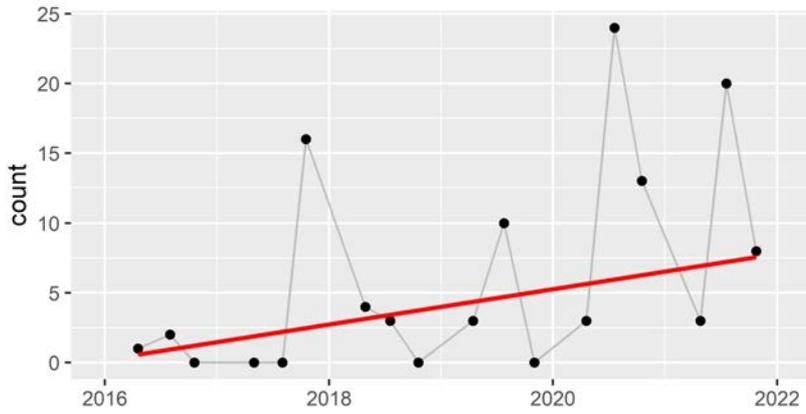
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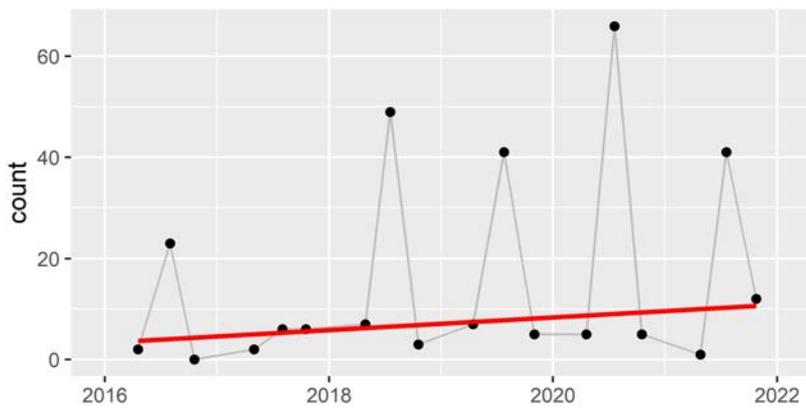
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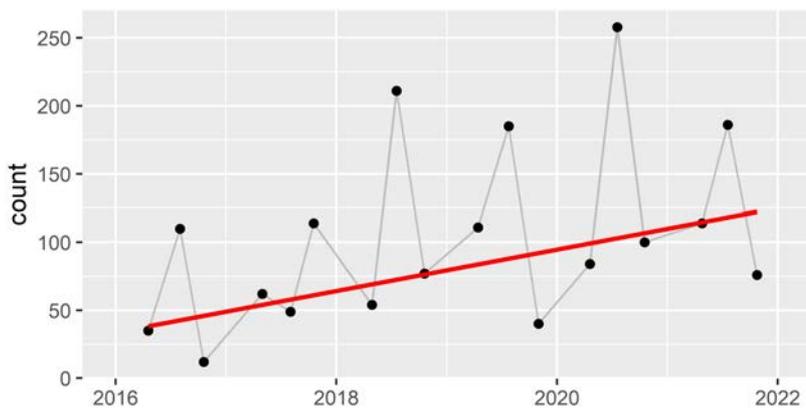
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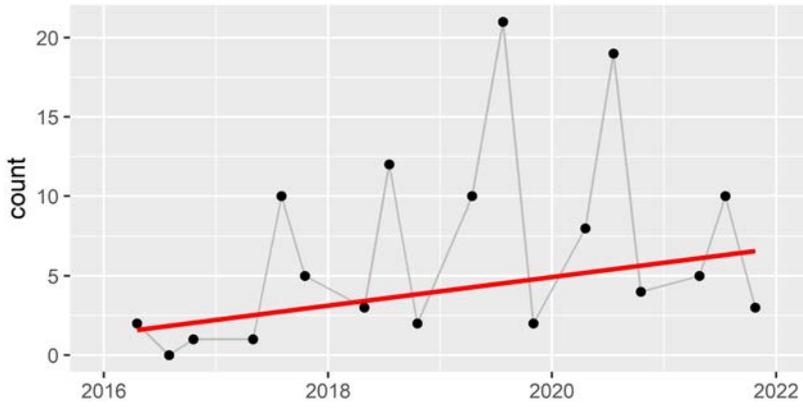
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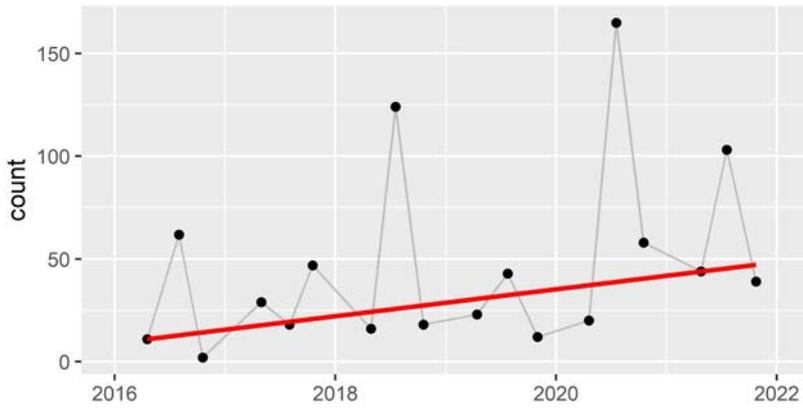
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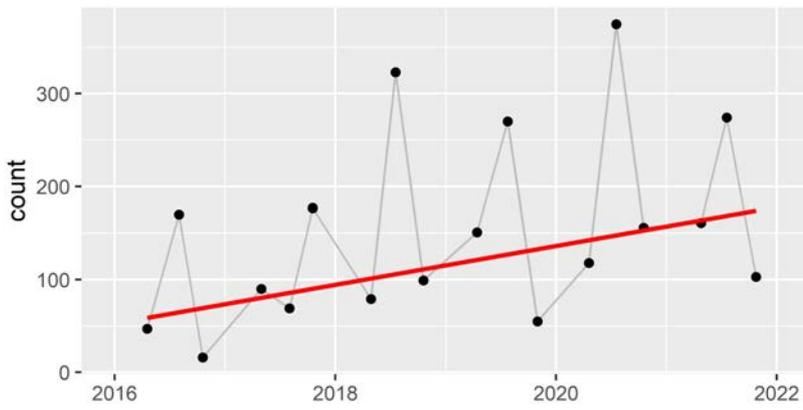
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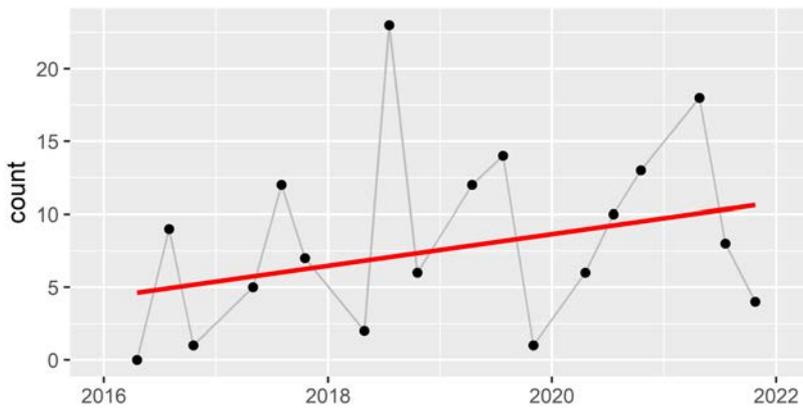
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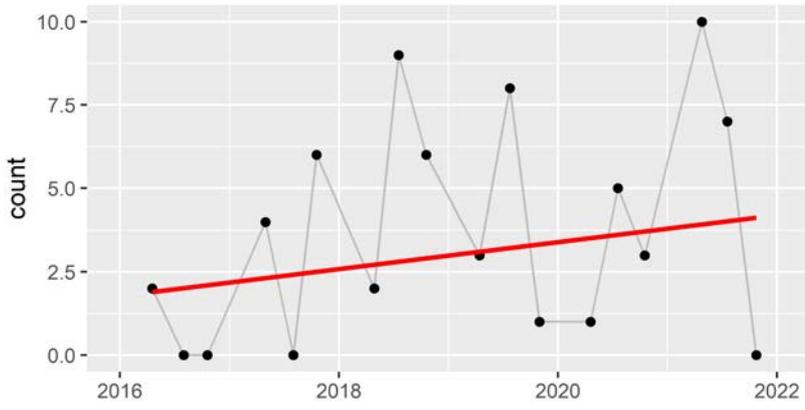
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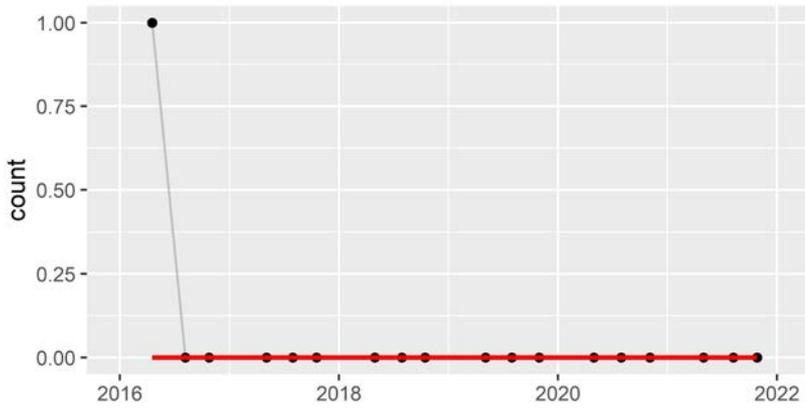
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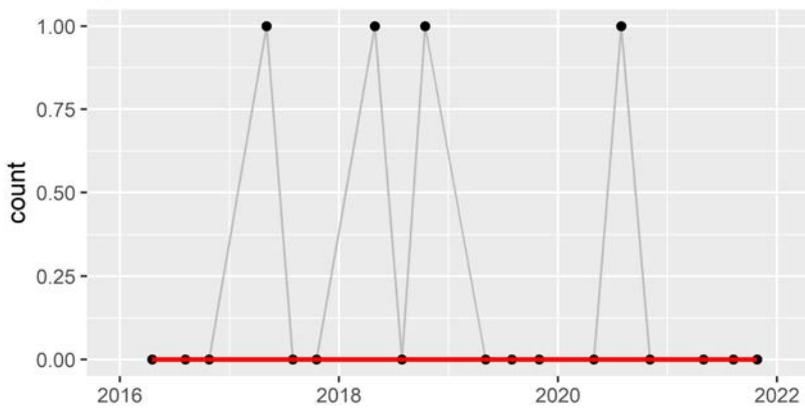
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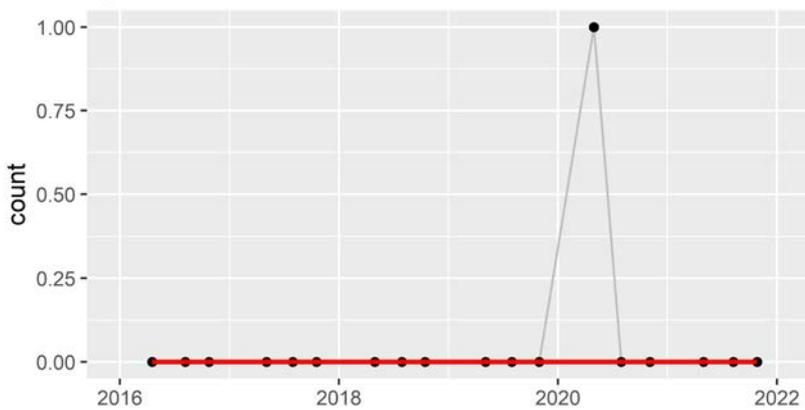
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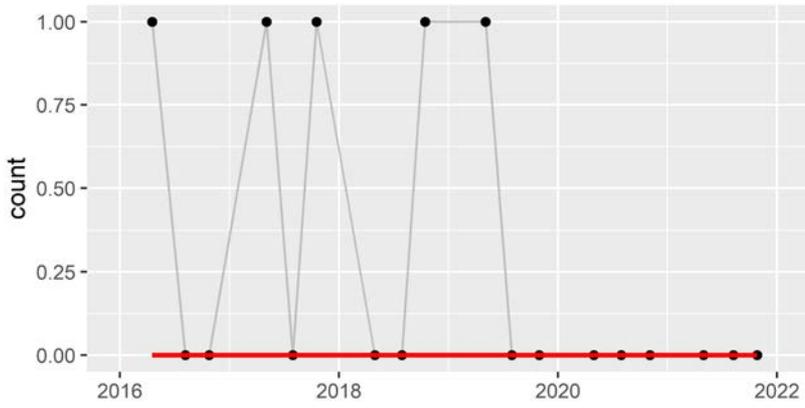
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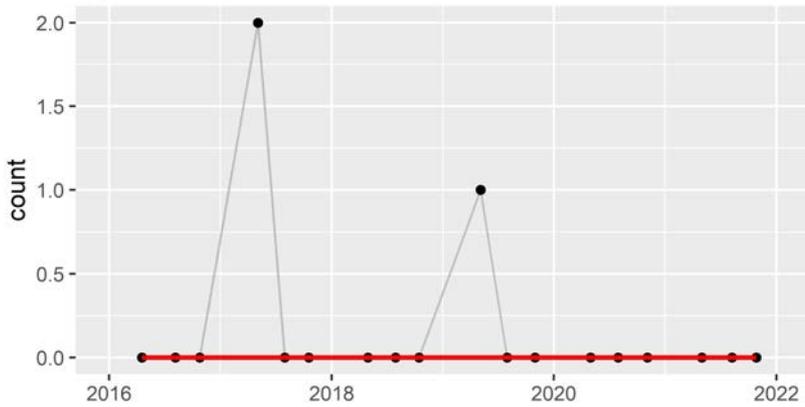
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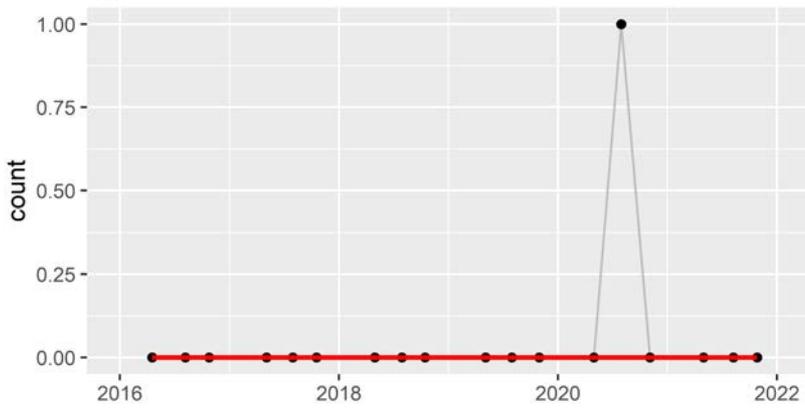
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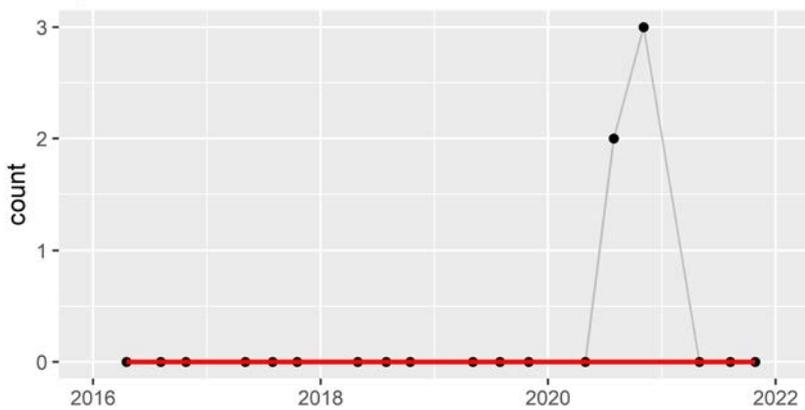
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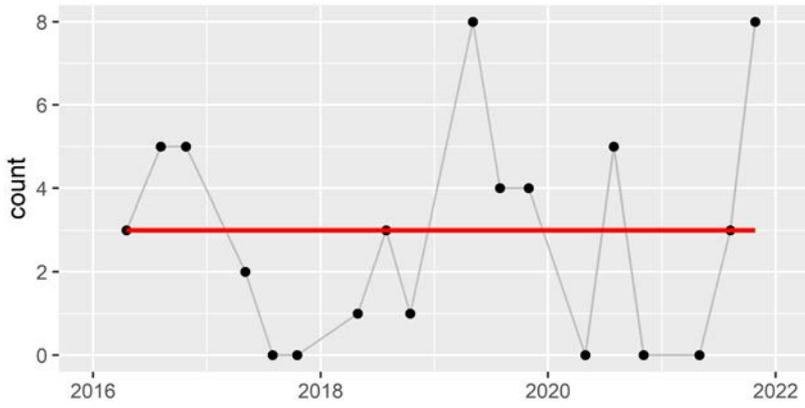
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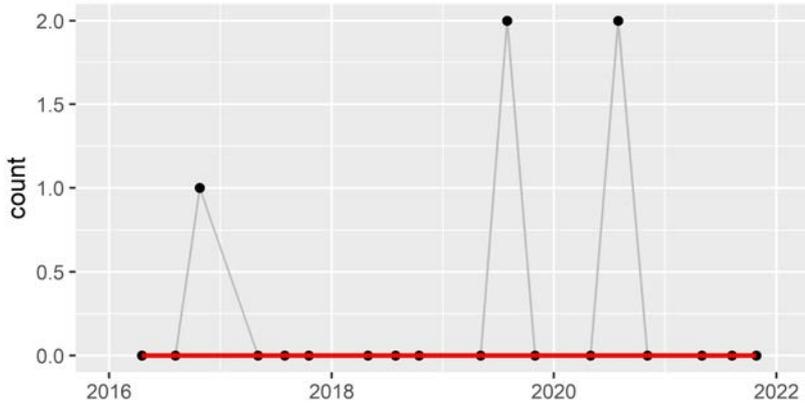
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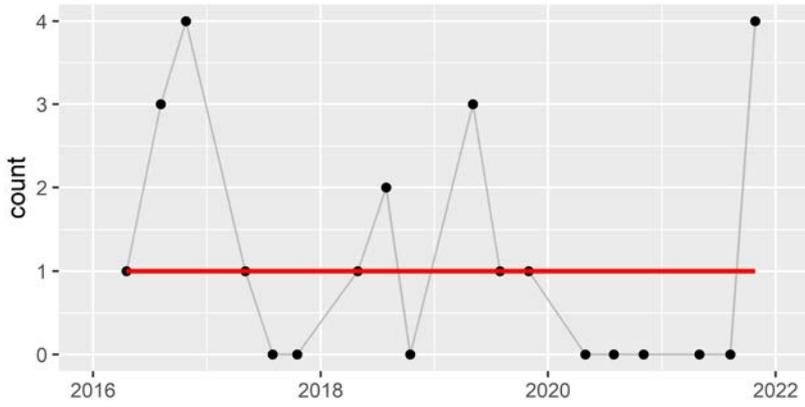
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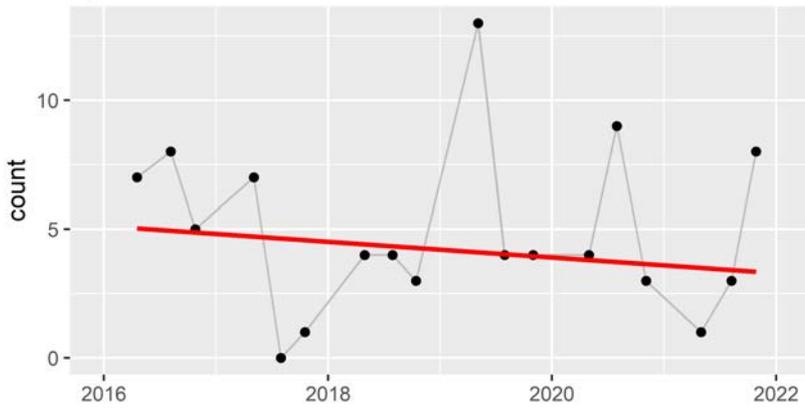
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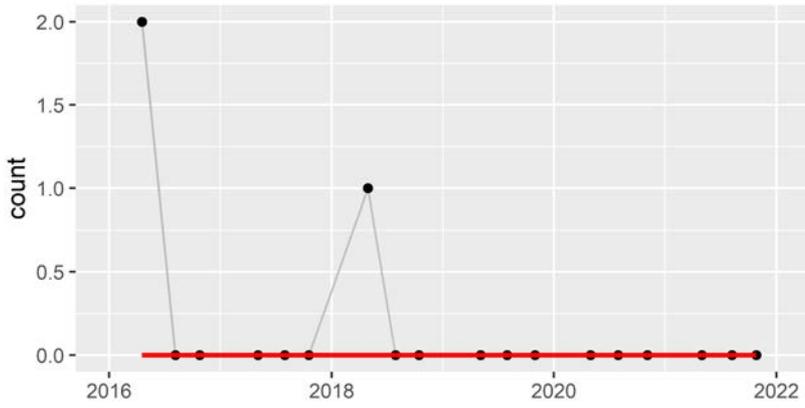
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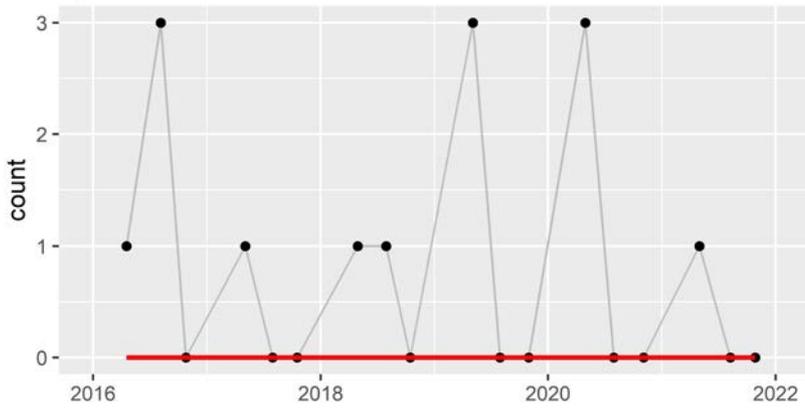
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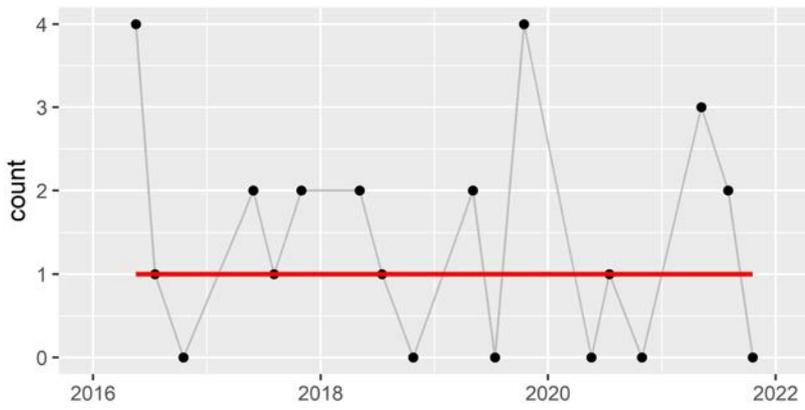
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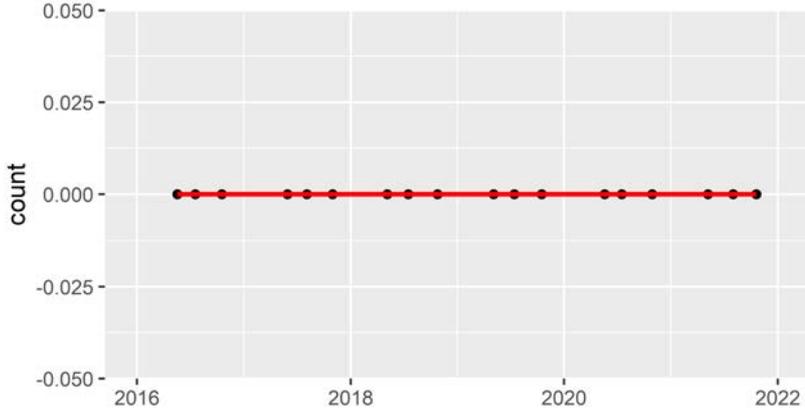
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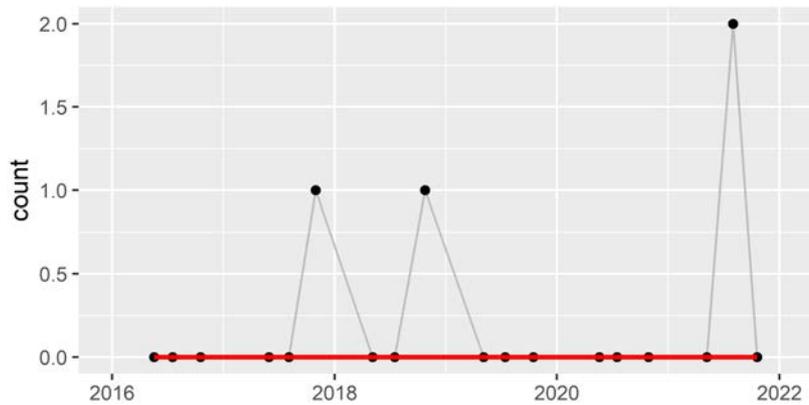
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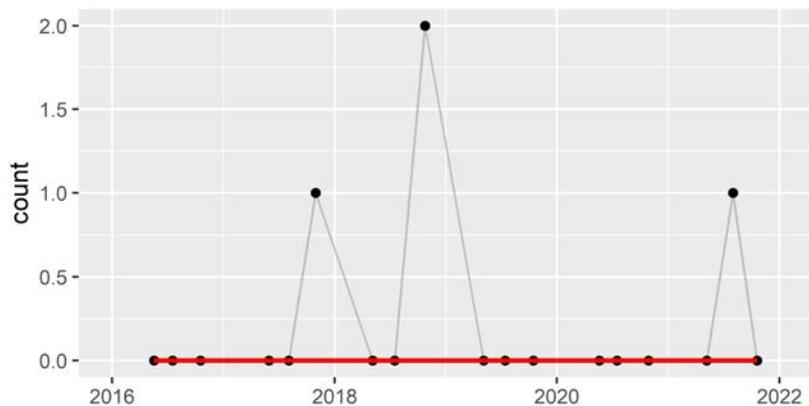
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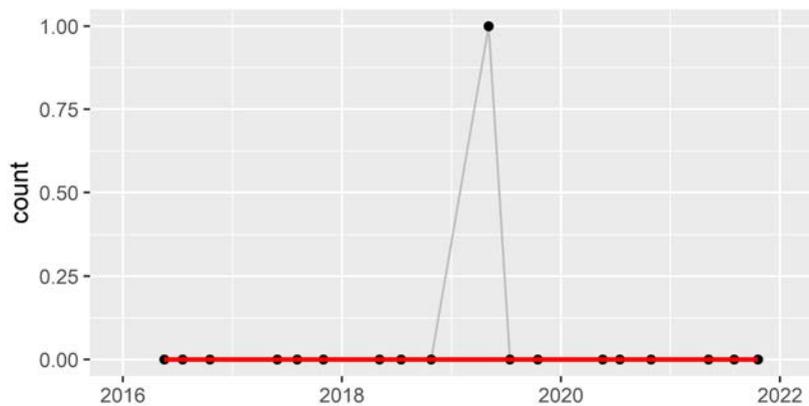
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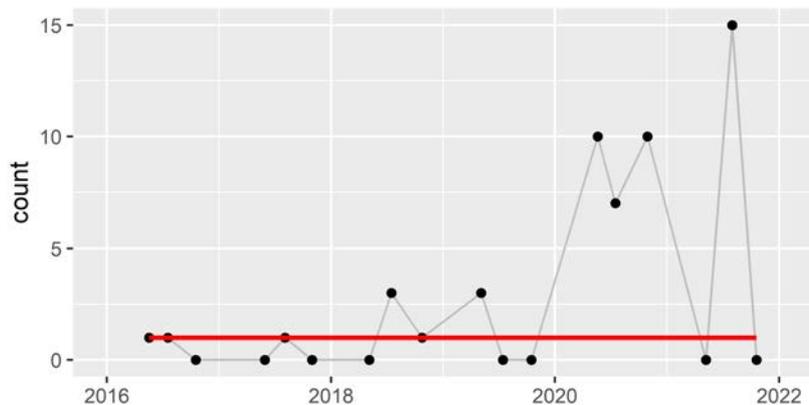
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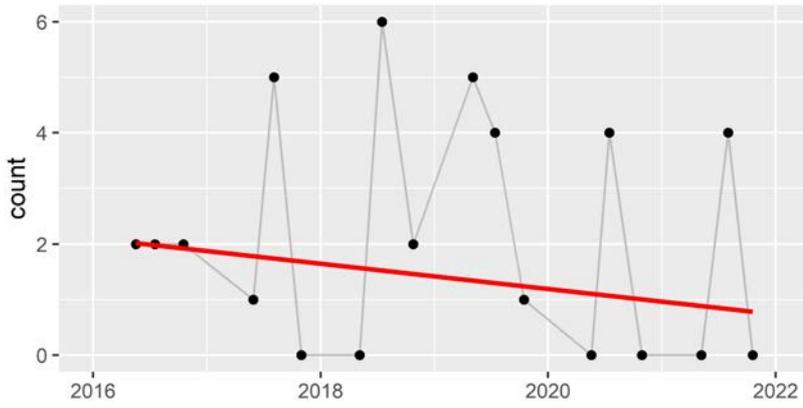
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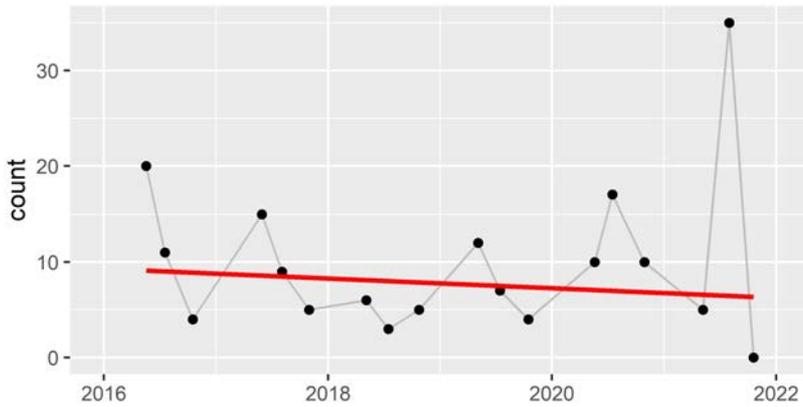
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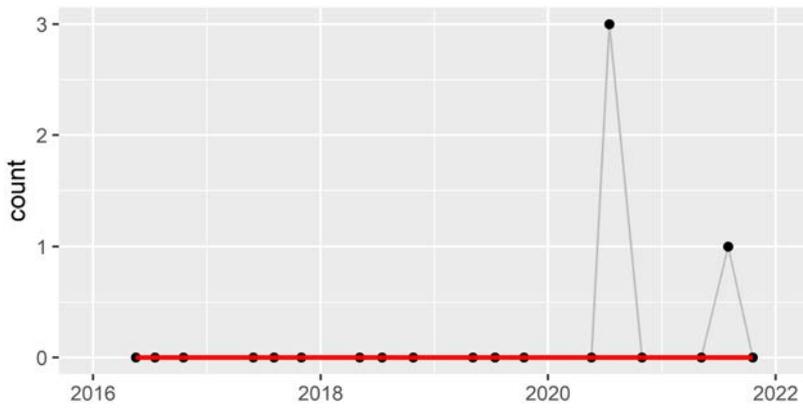
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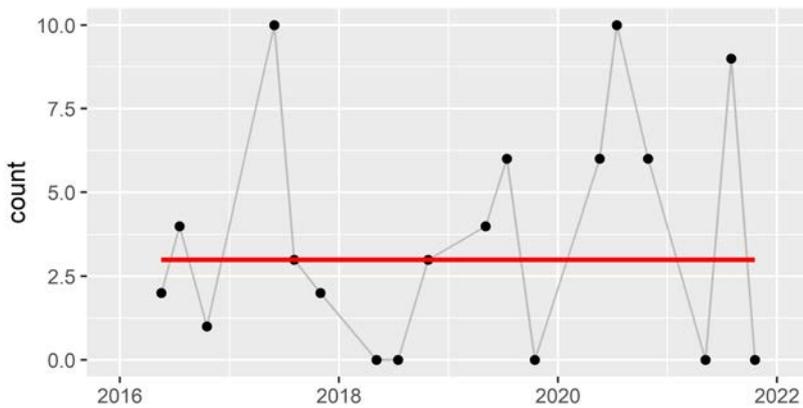
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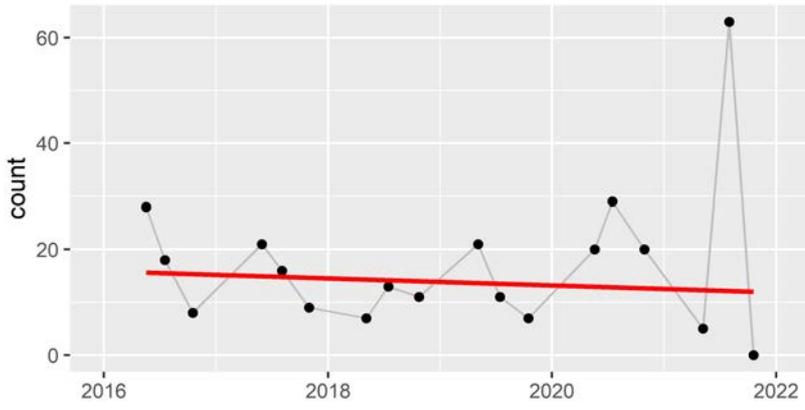
Storsand SANITET.MEDICINSKT



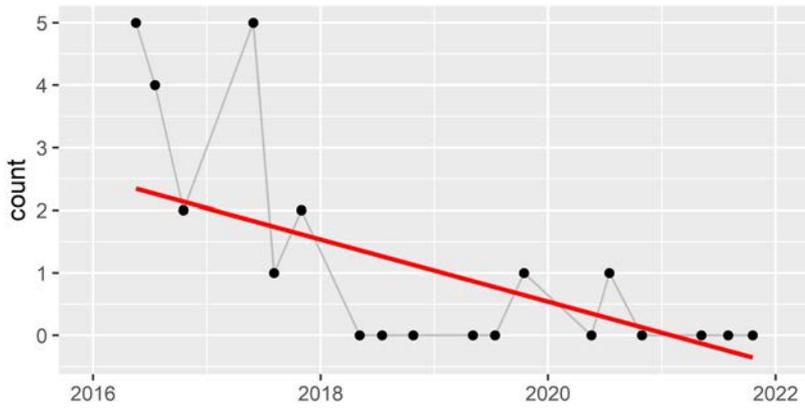
Storsand SUP



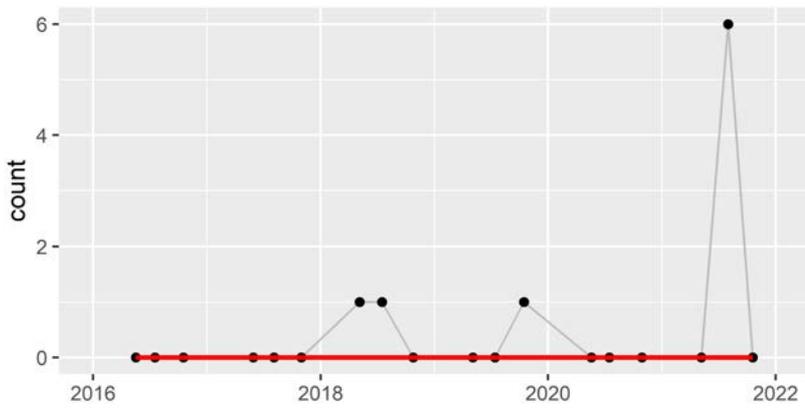
Storsand TC



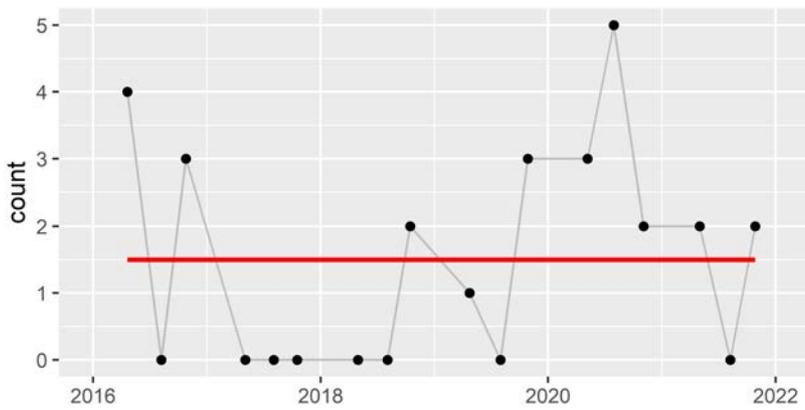
Storsand TRA



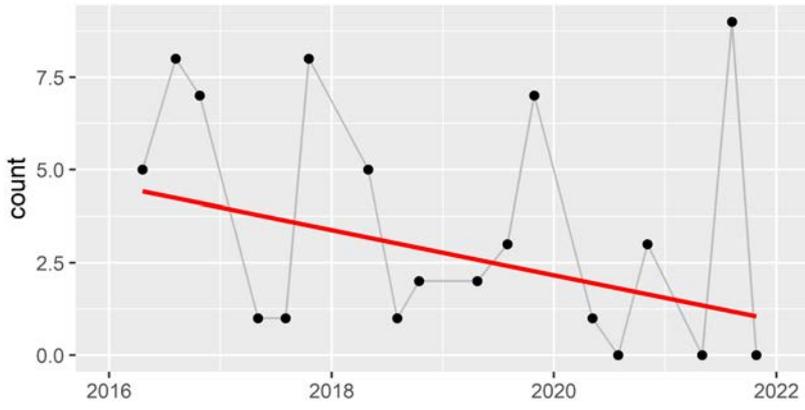
Storsand TYG



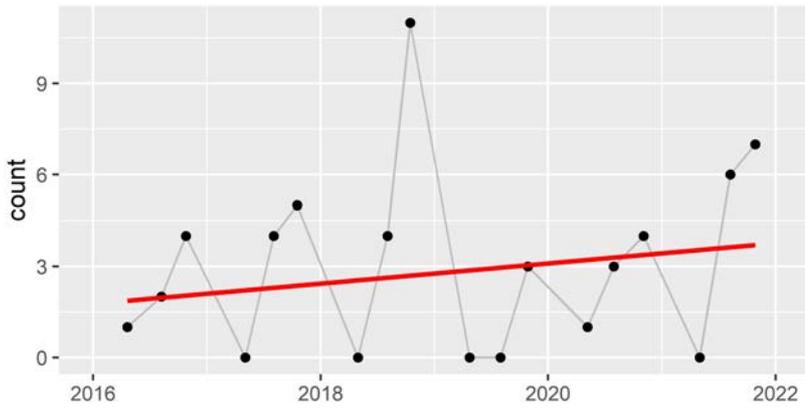
Tofta FISH



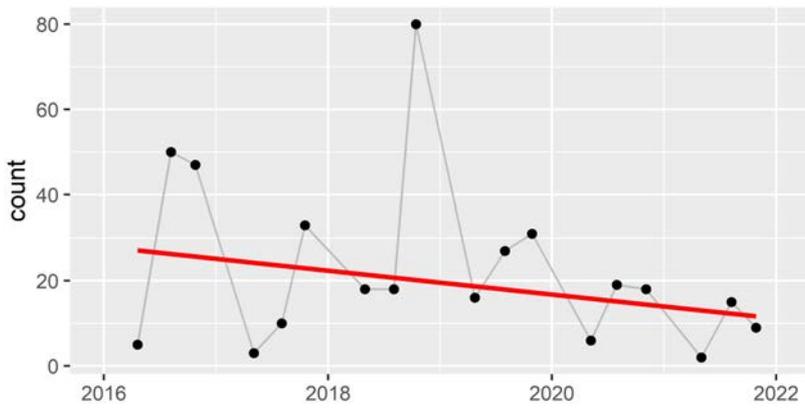
Tofta GLAS.KERAMIK



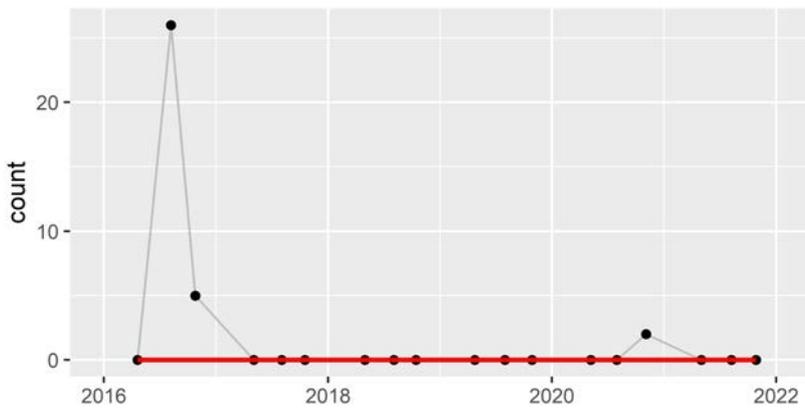
Tofta GUMMI



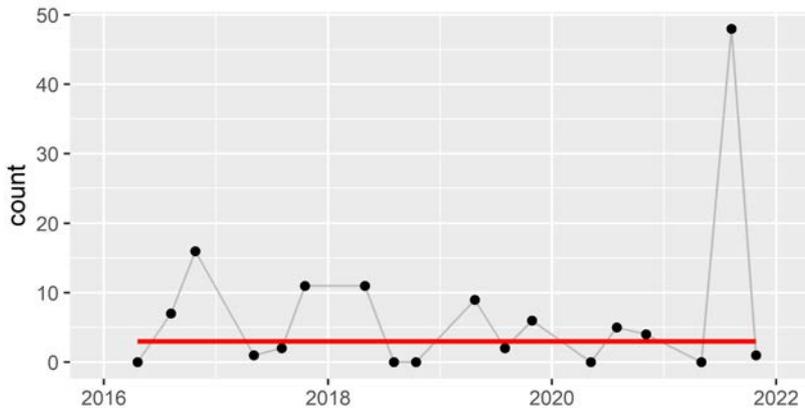
Tofta METALL



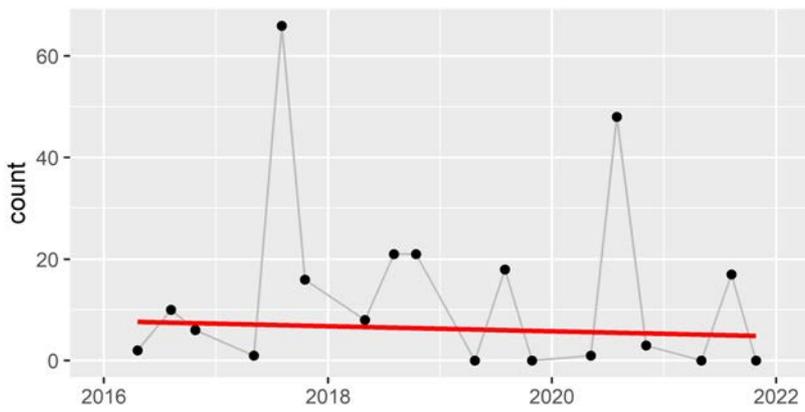
Tofta OLIKA.MATERIAL



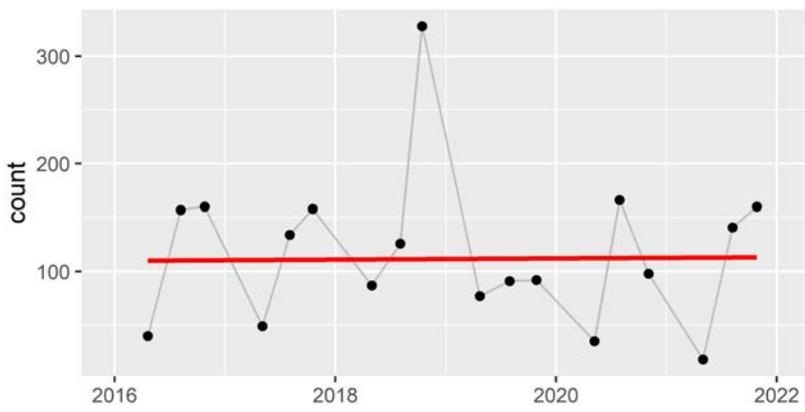
Tofta ORGANISKT



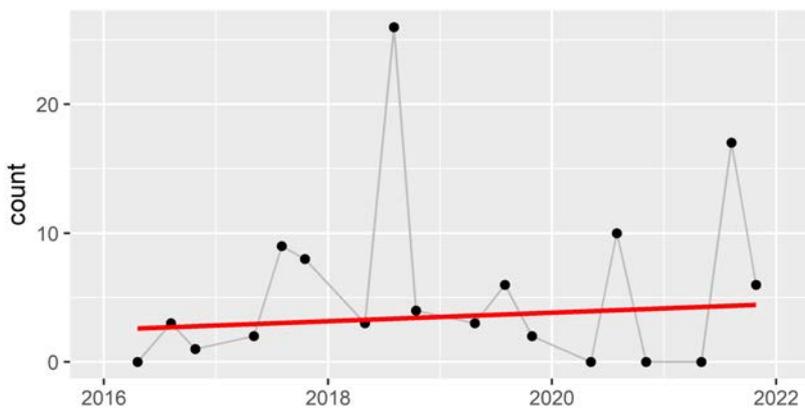
Tofta PAPPER.KARTONG



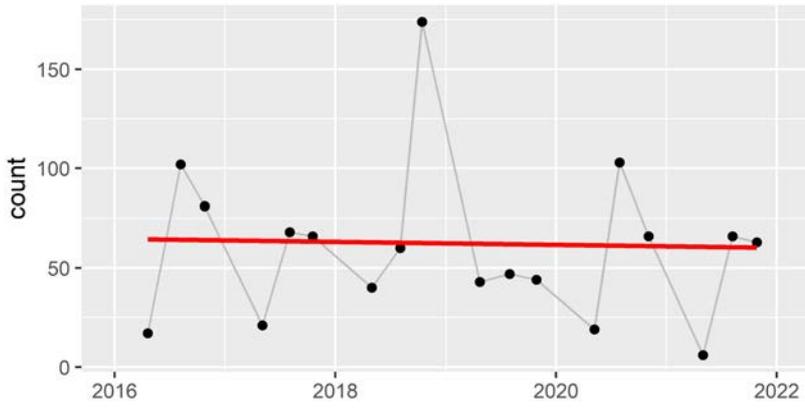
Tofta PLAST



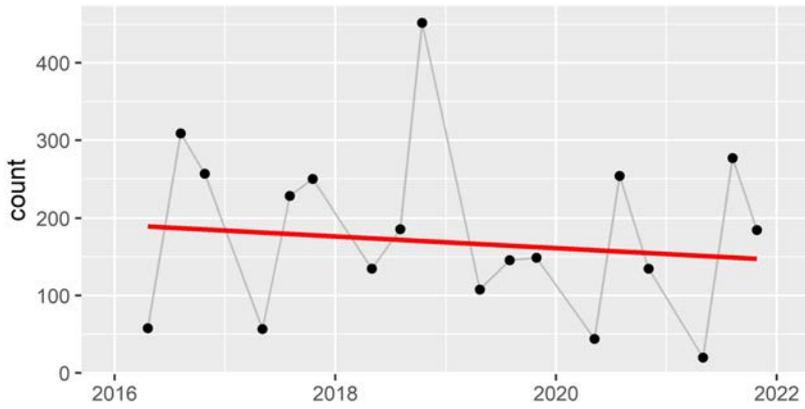
Tofta SANITET.MEDICINSKT



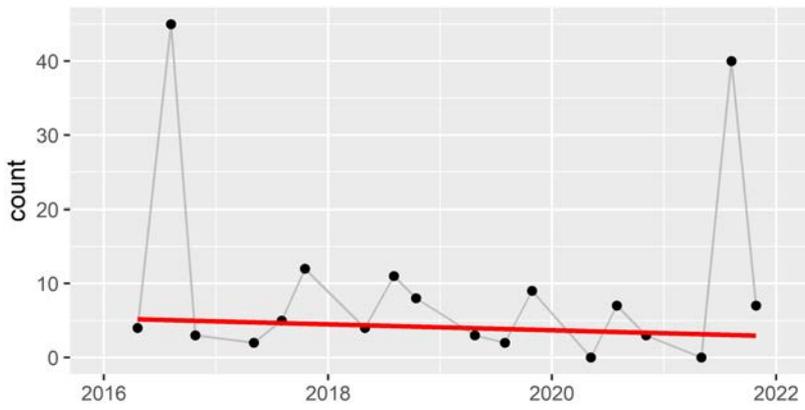
Tofta SUP



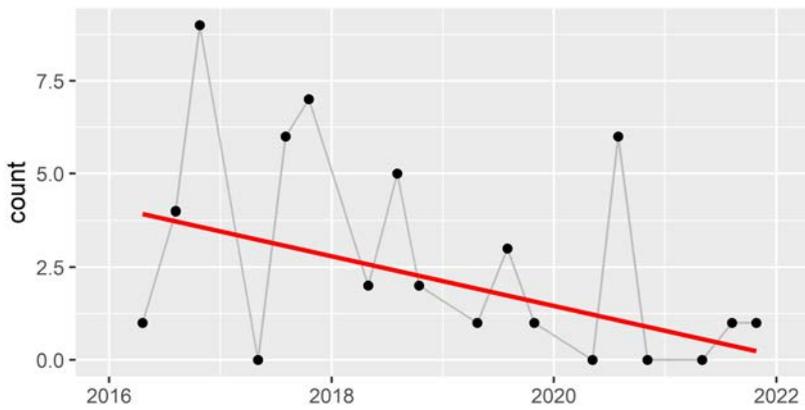
Tofta TC



Tofta TRA



Tofta TYG



Regional trend analysis

For each `region_code` and the type names and group codes specified in the settings file, the following statistics have been estimated for the period 2016-01-01 to 2021-12-31:

- the number of surveys (N);
- Theil-Sen slope: the median of all Theil-Sen slopes (https://en.wikipedia.org/wiki/Theil%E2%80%93Sen_estimator) within a region;
- p-value (<https://en.wikipedia.org/wiki/P-value>): the p-value associated with the one-tailed Regional Kendall test (Van Belle & Hughes, 1984 (<https://dx.doi.org/10.1029/WR020i001p00127>); Gilbert, 1987 (<https://www.osti.gov/biblio/7037501-statistical-methods-environmental-pollution-monitoring>)) to test the null hypothesis of
 - no monotonically *increasing* trend in case the regional Theil-Sen slope is greater than zero;
 - no monotonically *decreasing* trend in case the regional Theil-Sen slope is smaller than zero;

A p-value less than an *a priori* specified significance level (https://en.wikipedia.org/wiki/Statistical_significance) (e.g., often $\alpha = 0.05$), indicates a significant trend. If the p-value is greater than this significance level, we can't say that there is no trend. We can only conclude that our data do not show evidence for a significant trend (due to lack of data, noise, etc.).

The Regional Kendall test is a non-parametric test and as such does not make distributional assumptions on the data.

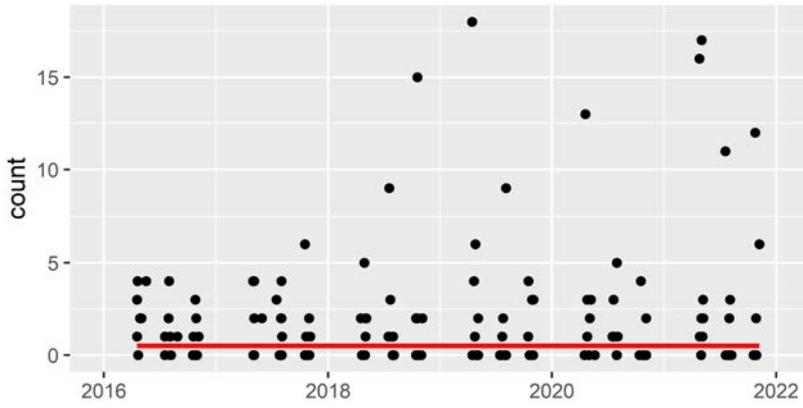
Note that the trend statistics can only be computed if all `location_code`s of a `region_code` have at least three records (surveys). If that is not the case, the table below contains NA.

region_code	type name / group code	N	slope	p-value
OS	PLAST	144	0.2873	0.1499
OS	TC	144	-0.02787	0.5000
OS	FISH	144	0	0.2947
OS	GLAS.KERAMIK	144	0	0.0216
OS	GUMMI	144	0	0.9473
OS	METALL	144	0	0.0489
OS	OLIKA.MATERIAL	144	0	0.0018
OS	ORGANISKT	144	0	0.9503
OS	PAPPER.KARTONG	144	0	0.4035
OS	SANITET.MEDICINSKT	144	0	0.9963
OS	SUP	144	0	0.4347
OS	TRA	144	0	0.0063
OS	TYG	144	0	0.4940

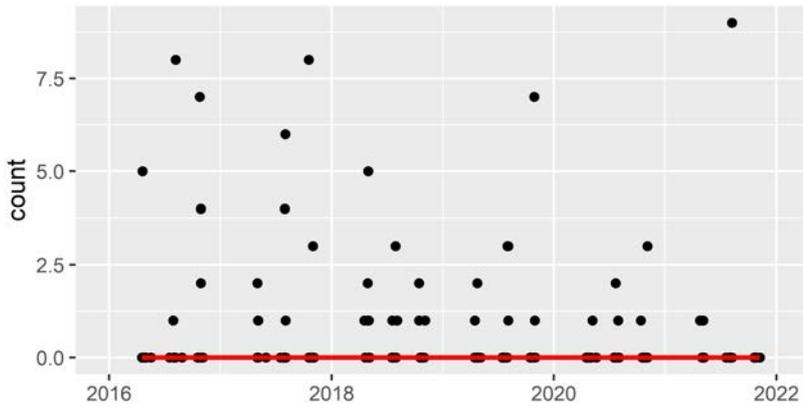
Time-series of the selected type names and group codes are given for the selected regions in the plots below (see also Settings). The lines and dots have the following meaning:

- coloured dots: observations;
- red line: Regional Theil-Sen trend line (its slope is given in the table above). Note that the trend line (red line) is only given in case there are at least three records (surveys) in each `location_code` to estimate the trend parameters.

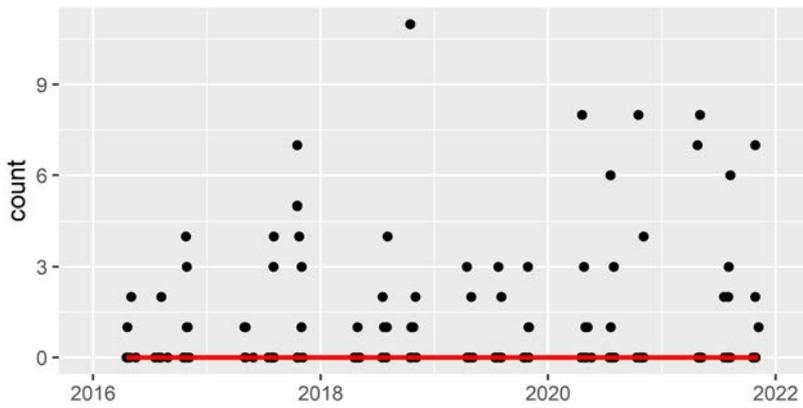
OS FISH



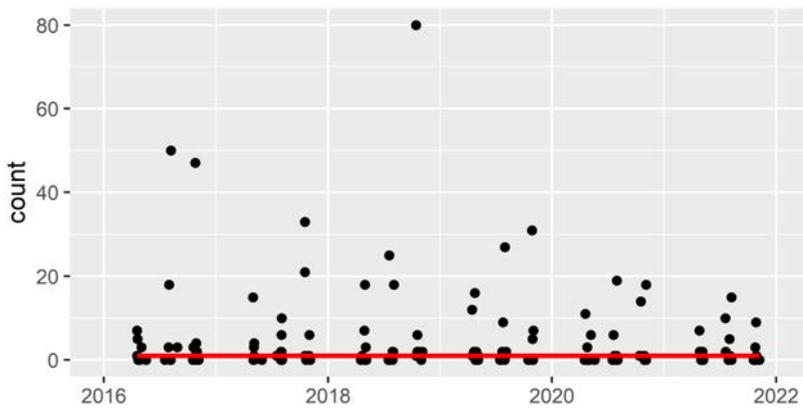
OS GLAS.KERAMIK



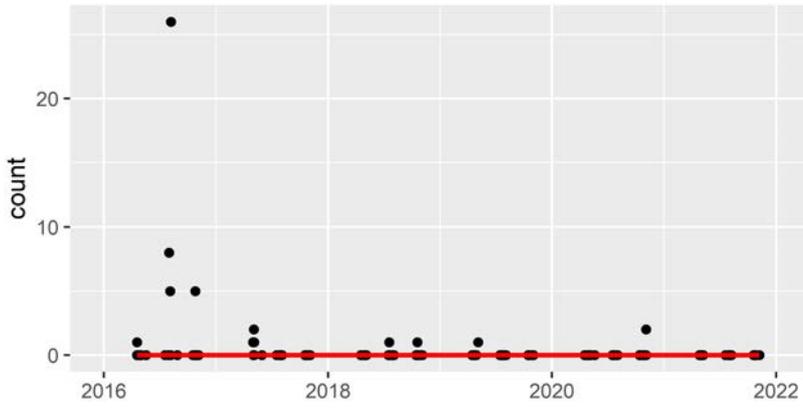
OS GUMMI



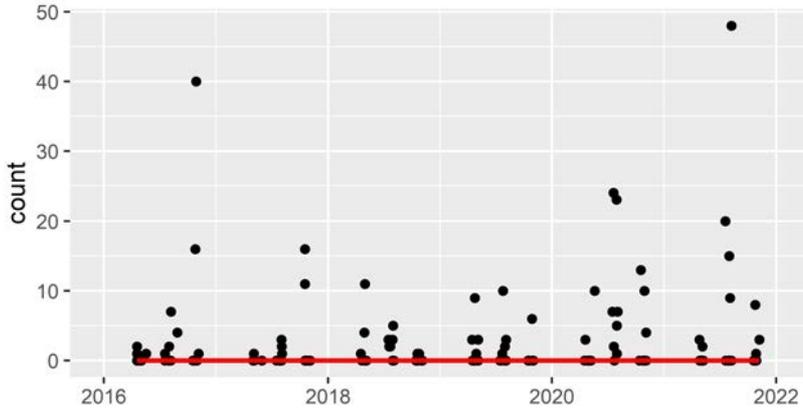
OS METALL



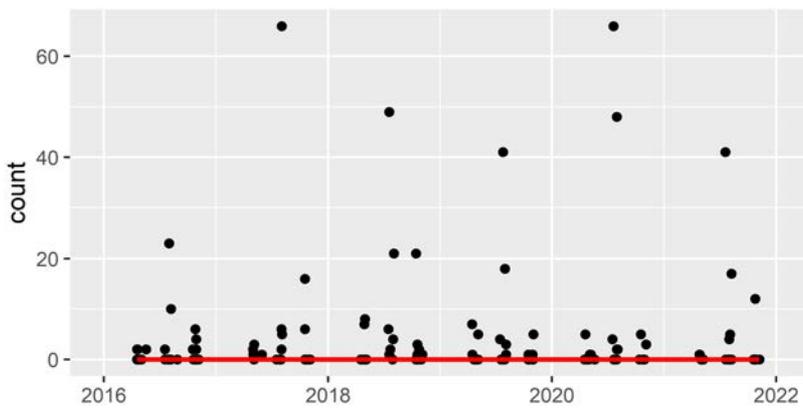
OS OLIKA.MATERIAL



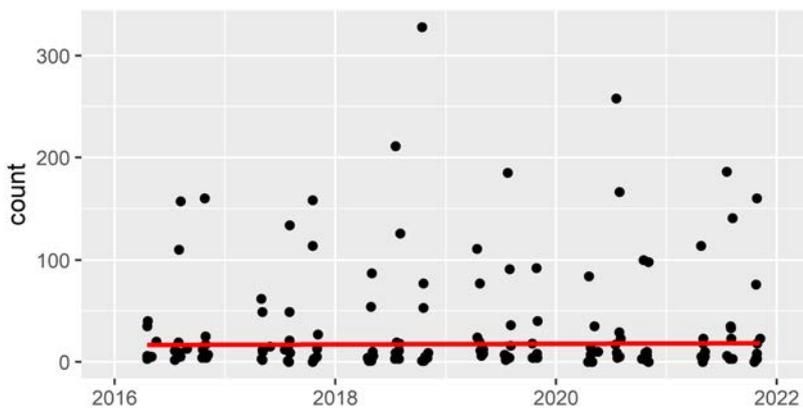
OS ORGANISKT



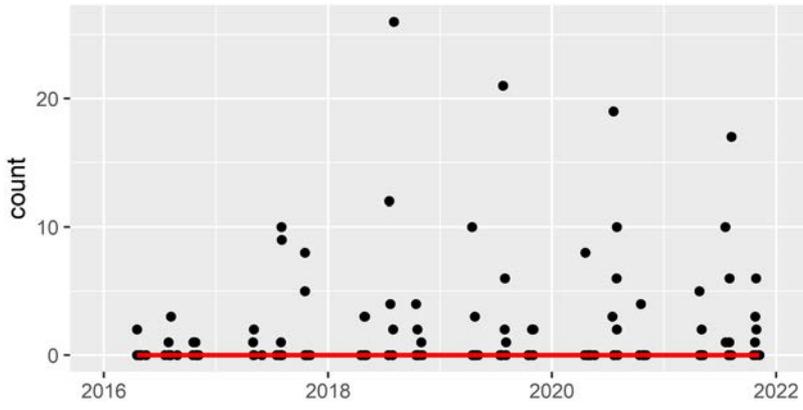
OS PAPPER.KARTONG



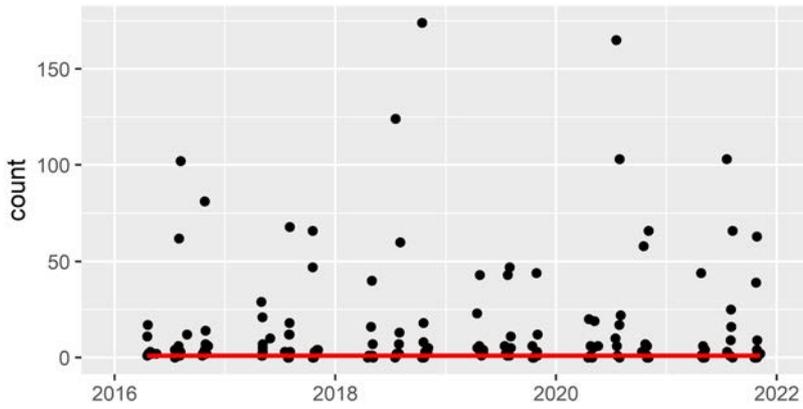
OS PLAST



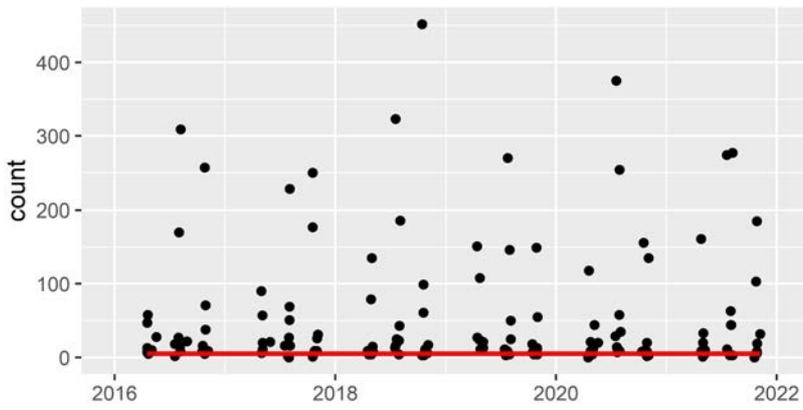
OS SANITET.MEDICINSKT



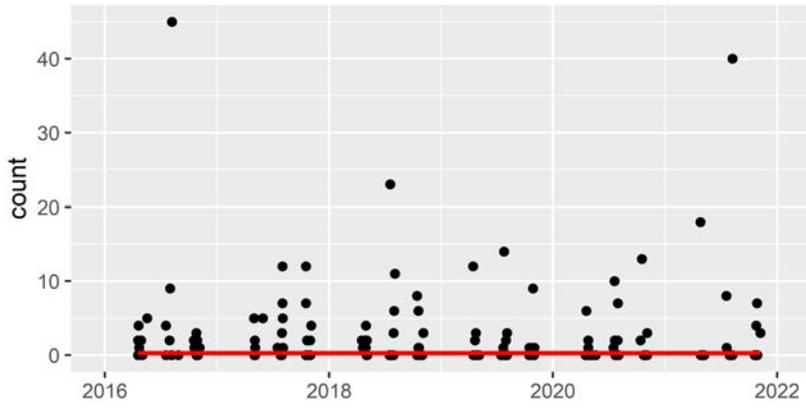
OS SUP



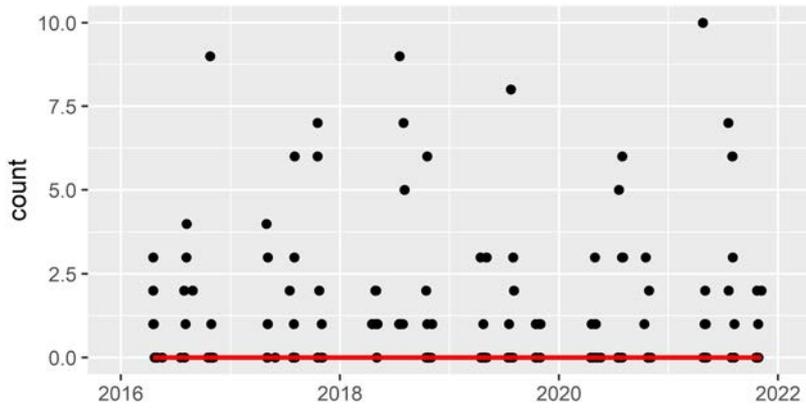
OS TC



OS TRA



OS TYG



Session Information

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R version 4.2.2 (2022-10-31 ucrt)
Platform: x86_64-w64-mingw32/x64 (64-bit)
Running under: Windows 10 x64 (build 22621)
```

```
Matrix products: default
```

```
locale:
```

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[1] LC_COLLATE=Swedish_Sweden.utf8 LC_CTYPE=Swedish_Sweden.utf8
[3] LC_MONETARY=Swedish_Sweden.utf8 LC_NUMERIC=C
[5] LC_TIME=Swedish_Sweden.utf8
```

```
attached base packages:
```

```
[1] stats      graphics  grDevices  utils      datasets  methods    base
```

```
other attached packages:
```

```
[1] stringr_1.4.1   readr_2.1.3     knitr_1.40      fs_1.5.2        ggplot2_3.4.0
[6] tidyr_1.2.1     purrr_0.3.5     dplyr_1.0.10    rlang_1.0.6     litteR_1.0.0
[11] openxlsx_4.2.5.1
```

```
loaded via a namespace (and not attached):
```

```
[1] tidyselect_1.2.0 xfun_0.34       bslib_0.4.1     lattice_0.20-45 splines_4.2.2
[6] tcltk_4.2.2      colorspace_2.0-3 vctrs_0.5.0     generics_0.1.3  htmltools_0.5.3
[11] mgcv_1.8-41      yaml_2.3.6      utf8_1.2.2      pillar_1.8.1    jquerylib_0.1.4
[16] glue_1.6.2       withr_2.5.0     bit64_4.0.5     lifecycle_1.0.3 munsell_0.5.0
[21] gtable_0.3.1     zip_2.2.2       evaluate_0.18   labeling_0.4.2  tzdb_0.3.0
[26] fastmap_1.1.0    parallel_4.2.2 fansi_1.0.3     highr_0.9       Rcpp_1.0.9
[31] scales_1.2.1     cachem_1.0.6    vroom_1.6.0     jsonlite_1.8.3  farver_2.1.1
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