pe_curat

June 17, 2025

1 Procesam datele pentru Midii

1.1 Coordonatele statiilor sunt

Nume	Lat	Lon
PMD	44.160792	28.681631
PCT	44.160792	28.657107
PMG	43.807017	28.582175
2MAI	43.779532	28.582378

1.2 Conditii de mediu

param	sezon	avg	std
T(oC)	Spring	19.013	0.24
	Summer	22.69	2.64
	Autumn	13.23	2.84
PSU	Spring	13.68	3.41
	Summer	15.30	1.12
	Autumn	15.11	1.17
CLR	Spring	10.63	10.70
	Summer	7.80	5.20
	Autumn	7.64	6.65

[1]:
```
import pandas as pd
from matplotlib import pyplot as plt
import matplotlib as mpl
import numpy as np
def get_size(t):
    L_inf = 125
    K = 0.23 # 0.03
    return L_inf*(1-np.exp(-K*t))
```

Figure export parameters.

[2]:
```
plt.rcParams["figure.figsize"] = [12.50, 6.50]
plt.rcParams["figure.autolayout"] = True
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```

```
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```

[3]:
```
mpl.rcParams
```

[3]:
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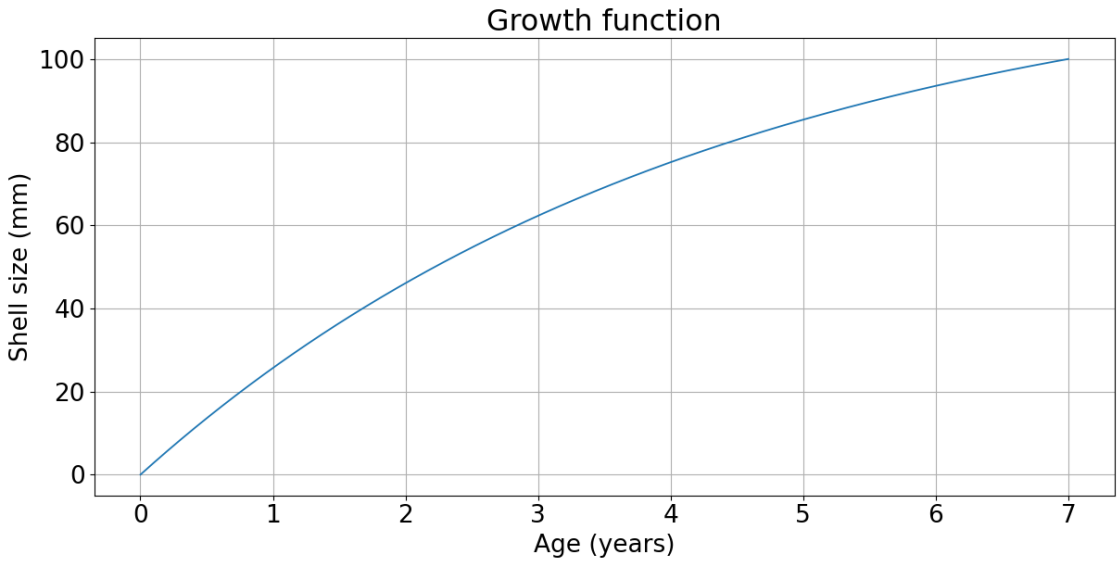
```

Size to age

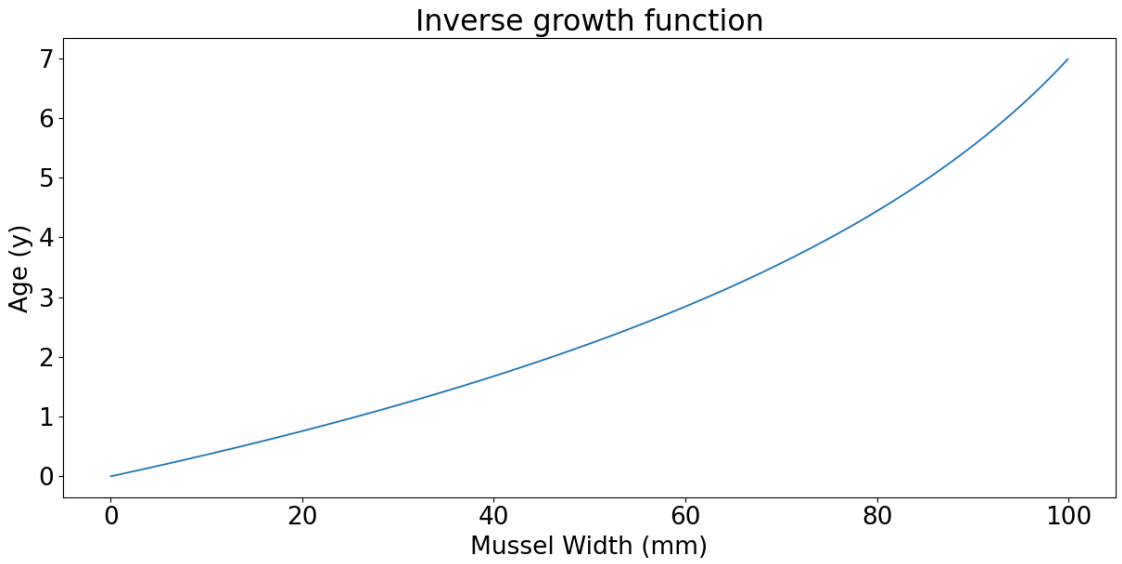
$$age[y] = 4.90511708e-6 * x^3 - s.50034061e-04 * x^2 + 4.53030305e-2 * x + 5.95602403e-2$$

[4]:
```
x = np.linspace(1E-3,7, 10000)
y = [get_size(b) for b in x]
plt.xlabel("Age (years)")
plt.ylabel("Shell size (mm)")
plt.title("Growth function")
plt.grid(which="both")
```

```
_ = plt.plot(x,y,linewidth=1.3)
plt.savefig("images/growth_func.png",dpi=400)
```



[5]:
```
# Compute the inverse function
from scipy.optimize import minimize
x = np.arange(np.min(y),np.max(y),0.1)
y = np.zeros(x.shape)
def diff(x,a):
    yt = get_size(x)
    return (yt - a )**2
for idx,x_value in enumerate(x):
    res = minimize(diff, 1.0, args=(x_value), method='Nelder-Mead', tol=1e-6)
    y[idx] = res.x[0]
_ = plt.plot(x,y, linewidth=1.3)
plt.title("Inverse growth function")
plt.ylabel("Age (y)")
plt.xlabel("Mussel Width (mm)")
plt.savefig("images/inverse_growth_fn.png", dpi=400)
```



[6]:
```
# Fit the growth function
f = np.polyfit(x,y,3)
inverse_growth_fit = np.poly1d(f)
inverse_growth_fit(75),inverse_growth_fit(65),inverse_growth_fit(25)
```

[6]:
```
(4.001071724778213, 3.1758106143780527, 0.9933866886673378)
```

[7]:
```
# We start working on the weight vs width - average values
# We simplify the high amplitude variations by the means of yearly average
# First we load the actual data
df = pd.read_csv("result.csv")
# the first column is the persisted index. we discard it as it is replaced for␣
 ↪the new instance
df.drop(columns=[df.columns[0]], inplace=True)
```

[8]:
```
df['Varsta [ani]'] = inverse_growth_fit(df[df.columns[4]]*10)
df[df.columns[43]].describe()
```

[8]:
```
count    3439.000000
mean        1.873866
std         0.964579
min         0.580282
25%         0.993387
50%         1.430061
75%         2.491842
max         4.001072
Name: Varsta [ani], dtype: float64
```

[9]:
```
df.to_csv("wth_age.csv")
```

[10]:
```
gwdf = df.groupby([df.columns[4]])[[df.columns[5], df.columns[6], df.
↪columns[7]]].mean()
```

[11]:
```
gwdf.index
```

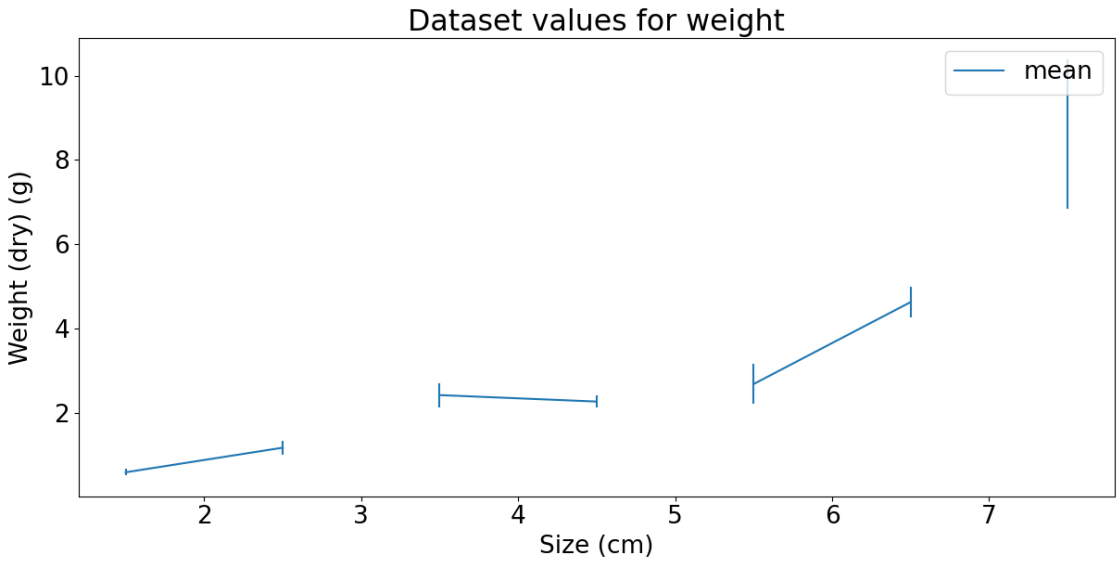
[11]:
```
Index([1.5, 2.5, 3.0, 3.5, 4.5, 5.0, 5.5, 6.5, 7.0, 7.5], dtype='float64',
name='Dimensiune (cm)')
```

[12]:
```
gwdf
```

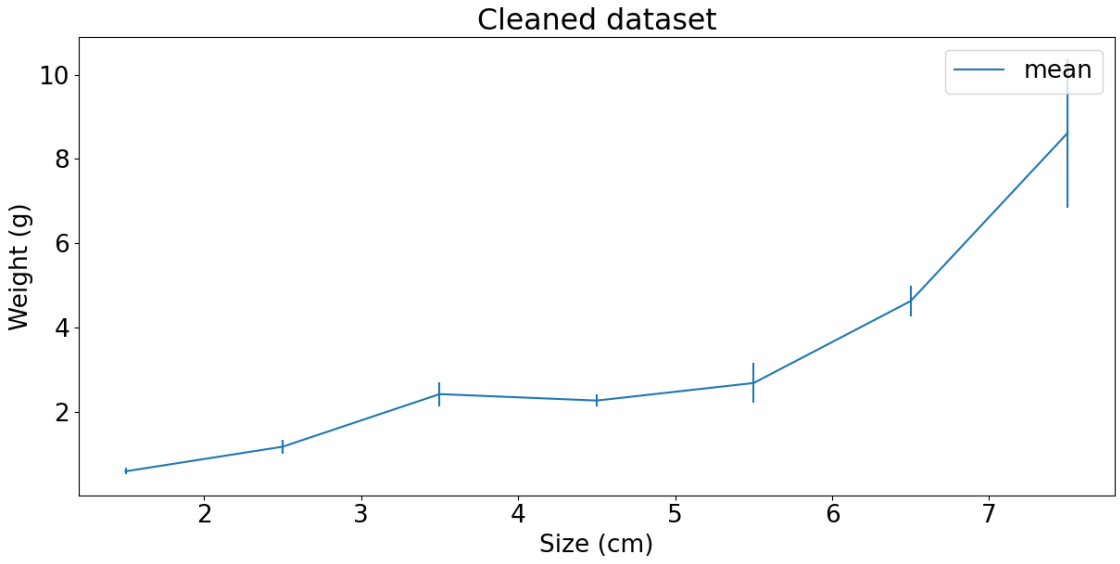
[12]:

Dimensiune (cm)	M1 (g)	M2	M3
1.5	0.580000	0.660000	0.510000
2.5	1.162456	1.339368	0.999544
3.0	NaN	NaN	NaN
3.5	2.130000	2.420000	2.700000
4.5	2.400000	2.120000	2.270000
5.0	NaN	NaN	NaN
5.5	3.040000	2.140000	2.860000
6.5	4.888216	4.784729	4.204469
7.0	NaN	NaN	NaN
7.5	10.553259	8.245185	7.057926

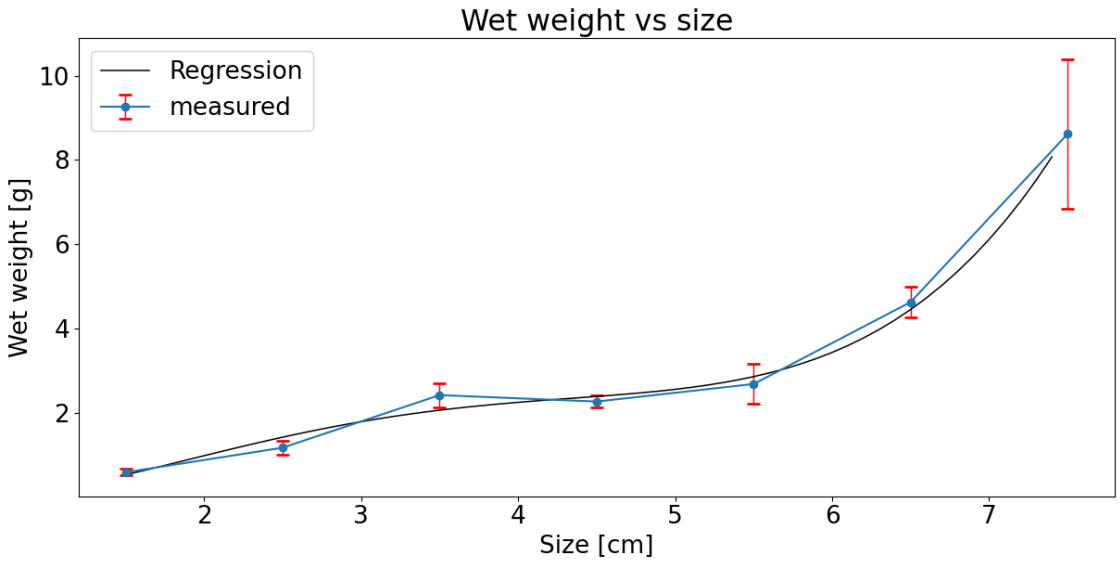
[13]:
```
avg = gwdf.mean(axis=1)
std = gwdf.std(axis=1)
gwdf['mean'] = avg
gwdf['std'] = std
_ = gwdf.plot(y="mean", yerr='std')
plt.title("Dataset values for weight")
plt.xlabel("Size (cm)")
plt.ylabel("Weight (dry) (g)")
plt.savefig("age_data.png", dpi=400)
```



[14]:
```
# now we build the regression dataset
mmgw = gwdf.dropna()
_ = mmgw.plot(y="mean", yerr="std")
plt.title("Cleaned dataset")
plt.xlabel("Size (cm)")
plt.ylabel("Weight (g)")
plt.savefig("images/weight_vs_size_cleaned.png", dpi=300)
```



[15]:
```
x = mmgw.index.tolist()
y = mmgw["mean"].values
yerr = mmgw["std"].values
# print(x)
# print(y)
f = np.polyfit(x,y,4)
p = np.poly1d(f)
plt.errorbar(x, y, yerr=yerr, fmt='-o', ecolor='red', capsize=5, capthick=2,␣
 ↪elinewidth=1, label="measured")
xx = np.arange(np.min(x), np.max(x), 0.1)
yy = [p(k) for k in xx]
_ = plt.plot(xx,yy, color='k',linewidth=1.1, label="Regression")
plt.xlabel("Size [cm]")
plt.ylabel("Wet weight [g]")
plt.legend()
plt.title("Wet weight vs size")
plt.savefig("images/Wet_weight_vs_size.png", dpi=400)
```



[16]:
```
# The polynomial fn that describes the weight
weight_from_dim = p
weight_from_dim
```

[16]:
```
poly1d([ 0.02171418, -0.27103738,  1.0708402 , -0.80818823,  0.13159321])
```

[17]:
```
df["mass [g]"] = weight_from_dim(df[df.columns[4]])
```

[18]:
```
df["debit [m3/year]"] = (364*24*df["mass [g]"]*.3)/1000
```

[19]:
```
df[df.columns[-1]].describe()
```

[19]:
```
count    3439.000000
mean        7.119393
std         4.632783
min         1.372980
25%         3.714001
50%         5.394872
75%         7.483589
max        22.712020
Name: debit [m3/year], dtype: float64
```

1.3 Now we translate the labels

[20]:
```
def translate_season(avalue):
    if avalue == 'Primavara':
        return 'Spring'
    if avalue == 'Toamna':
        return 'Autumn'
    if avalue == 'Vara':
        return "Summer"

def translate_substrat(avalue):
    if avalue == "Substrat pietros calcaros":
        return "calcareous rock substrate"
    if avalue == "Piloni metal ponton/Funii plastic":
        return "pontoon metal pillars/plastic ropes"
    if avalue == "Coca navei":
        return "ship's hull"
    if avalue == "Bloc ciment dana":
        return "harbour concrete quay wall"
    if avalue == "Bloc ciment faleza":
        return "cement block cliff"
    if avalue == "Flotoare plastic ponton":
        return "pontoon plastic floats"

def get_station_lat(station):
    if station == "PMG":
        return 43.807017
    if station == "2MAI":
        return 43.779532
    if station == "PMD":
        return 44.342436
    return 44.160792

def get_station_lon(station):
    if station == "PMD":
```

```
        return 28.681631
    if station == "PCT":
        return 28.657107
    if station == "PMG":
        return 28.582175
    return 28.582378
```

[21]:
```
df[['Season']] = df[['Sezon']].applymap(translate_season)
df[['Substrate']] = df[['Substrat']].applymap(translate_substrat)
df[['Latitude']] = df[['Statie']].applymap(get_station_lat)
df[['Longitude']] = df[['Statie']].applymap(get_station_lon)
```

[22]:
```
# df['Substrate'].to_list()
```

[23]:
```
# df.to_csv("data/cleaned.csv")
```

[24]:
```
# df = pd.read_csv("data/cleaned.csv")
```

[25]:
```
# df.drop(columns=[df.columns[0]], inplace=True)
```

[26]:
```
df["lifetime_flow [m3]"] = df['Varsta [ani]']*df["debit [m3/year]"]
```

[27]:
```
df["Microfibres"] = df['MFB-TA'].fillna(0) + df['MFB-N'].fillna(0) +␣
 ↪df['MFB-Ab'].fillna(0) + df['MFB-Re'].fillna(0) + df["MFB-Vr"].fillna(0)
df["Microfragments"] = df['MFG-AT-W'].fillna(0)*df['MFG-AT-h'].fillna(0) +␣
 ↪df['MFG-N-W'].fillna(0)*df['MFG-N-h'].fillna(0) + df['MFG-Ab-W'].
 ↪fillna(0)*df['MFG-Ab-h'].fillna(0) + df['MFG-RE-w'].fillna(0)*df['MFG-RD-h'].
 ↪fillna(0) + df['MFG-Vr-W'].fillna(0)*df['MFG-Vr-h'].fillna(0)
df["Micropellets"] = df["MPL-TA"].fillna(0) + df["MPL-N"].fillna(0) +␣
 ↪df["MPL-Ab"].fillna(0) + df["MPL-RE"].fillna(0) + df["MPL-Ve"].fillna(0)
df["Microfilms"] = df["MFL-TA-W"].fillna(0)*df['MFL-TA-h'].fillna(0) +␣
 ↪df["MFL-N-W"].fillna(0)*df['MFL-N-H'].fillna(0) + df["MFL-Ab-W"].
 ↪fillna(0)*df['MFL-Ab-H'].fillna(0) + df["MFL-RE-W"].fillna(0)*df['MFL-RE-H'].
 ↪fillna(0) + df["MFL-Vr-W"].fillna(0)*df['MFL-VR-H'].fillna(0)
```

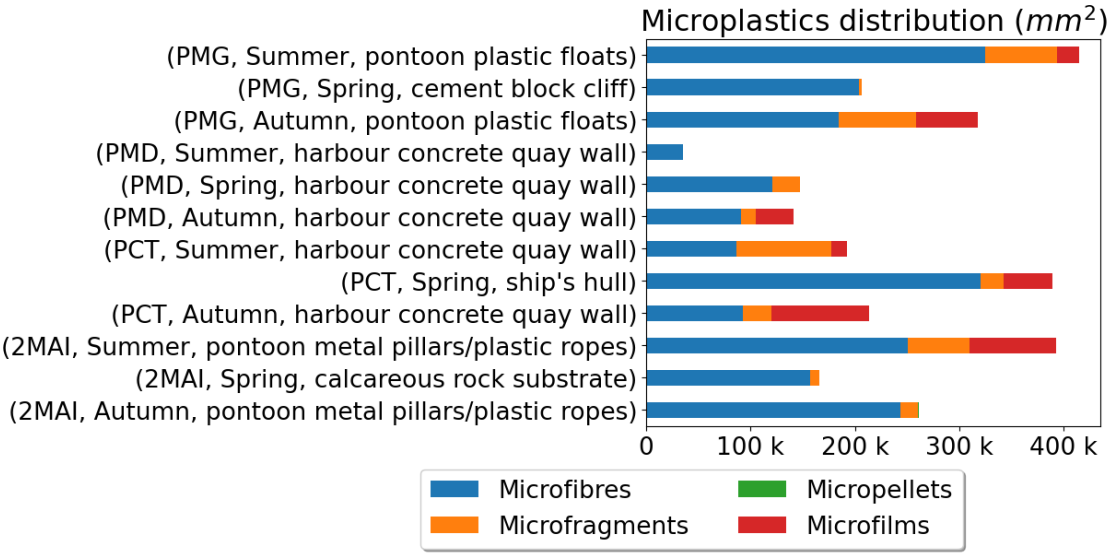
[28]:
```
df['Microfilms'].describe()
```

[28]:
```
count     3439.000000
mean       102.593386
std       1911.542966
min          0.000000
25%          0.000000
50%          0.000000
75%          0.000000
max      51496.680800
Name: Microfilms, dtype: float64
```

[29]:
```
df.to_csv("data/cleaned.csv")
```

[30]:
```
# df.columns, len(df.columns)
```

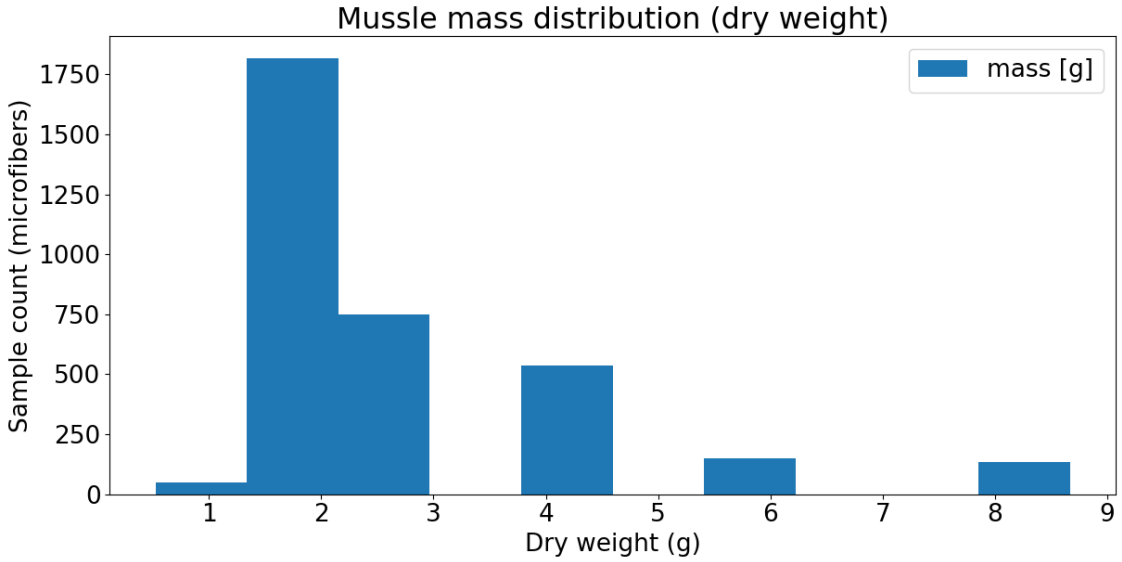
[31]:
```
from matplotlib.ticker import EngFormatter, LogFormatter, ScalarFormatter,␣
 ↪StrMethodFormatter
# formatter = StrMethodFormatter('{x:,}')
formatter = EngFormatter()
# formatter.set_powerlimits((-1, 1))
cols = ["Statie","Season","Substrate"] + df.columns[51:].tolist()
df2 = df[cols]
df2 = df2.groupby(["Statie","Season","Substrate"]).sum()
ax = df2.plot(kind="barh", stacked=True)
ax.legend(loc='upper center', bbox_to_anchor=(0.1, -0.08),
          fancybox=True, shadow=True, ncol=2)
ax.xaxis.set_major_formatter(formatter)
plt.title("Microplastics distribution ($mm^2$)")
_ = plt.ylabel("")
plt.savefig("images/fig7.png",dpi=400)
```



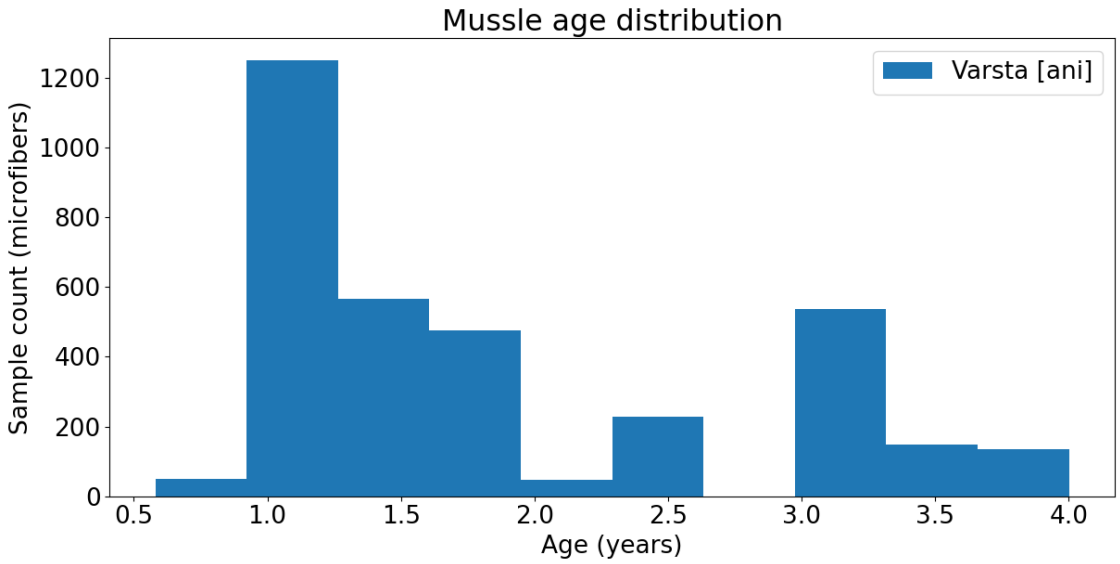
[32]:
```
plastic_rho = 1.4
def compute_grams_MFB(avalue):
    fv = float(avalue) # asta e lungimea
    return 1.4*((fv*np.pi*(0.05**2))/3000)
def compute_grams_MFL(avalue):
    fv = float(avalue) # asta e aria
    return plastic_rho*((0.005*fv)/3000)
def compute_grams_MFG(avalue):
```

```
    fv = float(avalue) # asta e aria
    return plastic_rho*((0.001*fv)/3000)
def compute_grams_MPL(avalue):
    fv = float(avalue)
    return plastic_rho*((0.072*fv)/3000)
```

[33]:
```
_ = df.plot(kind="hist", y="mass [g]")
_ = plt.title("Mussle mass distribution (dry weight)")
_ = plt.ylabel("Sample count (microfibers)")
_ = plt.xlabel("Dry weight (g)")
plt.savefig("images/mussle_mass_dist.png",dpi=400)
```

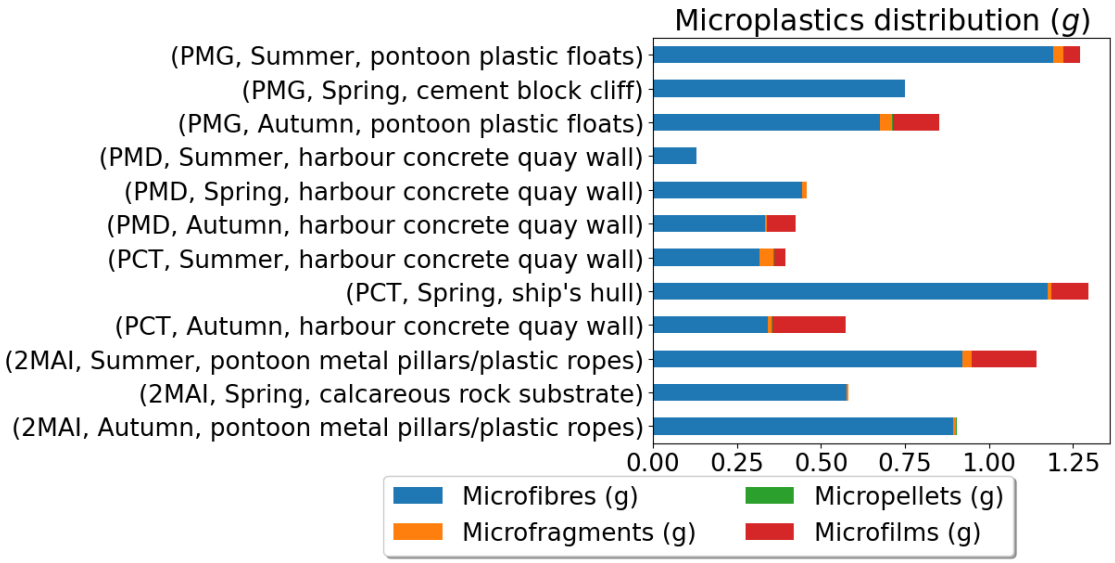


[34]:
```
_ = df.plot(kind="hist", y='Varsta [ani]')
_ = plt.title("Mussle age distribution")
_ = plt.ylabel("Sample count (microfibers)")
_ = plt.xlabel("Age (years)")
plt.savefig("images/mussle_age_dist.png",dpi=400)
```



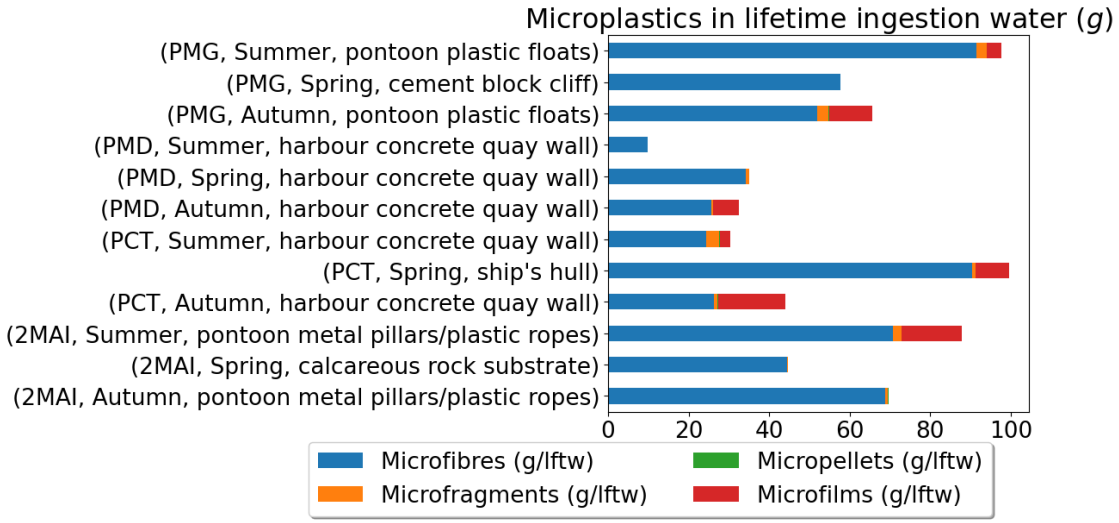
[35]:
```
df3 = df2.groupby(["Statie","Season","Substrate"]).sum()
df3[['Microfibres (g)']] = df3[['Microfibres']].applymap(compute_grams_MFB)
df3[['Microfragments (g)']] = df3[['Microfragments']].
 ↪applymap(compute_grams_MFG)
df3[['Micropellets (g)']] = df3[['Micropellets']].applymap(compute_grams_MPL)
df3[['Microfilms (g)']] = df3[['Microfilms']].applymap(compute_grams_MFL)
df3 = df3[df3.columns[4:]]
```

[36]:
```
_ = df3.plot(kind="barh", stacked=True).legend(loc='upper center',␣
 ↪bbox_to_anchor=(0.1, -0.05),
          fancybox=True, shadow=True, ncol=2)
plt.title("Microplastics distribution ($g$)")
_ = plt.ylabel("")
plt.savefig("images/fig8.png",dpi=400)
```



[37]:
```
def to_flow(avalue):
    retention_coef = 0.013
    return float(avalue)/retention_coef
```

[38]:
```
df4 = df3.groupby(["Statie","Season","Substrate"]).sum()
df4[['Microfibres (g/lftw)']] = df4[['Microfibres (g)']].applymap(to_flow)
df4[['Microfragments (g/lftw)']] = df4[['Microfragments (g)']].applymap(to_flow)
df4[['Micropellets (g/lftw)']] = df4[['Micropellets (g)']].applymap(to_flow)
df4[['Microfilms (g/lftw)']] = df4[['Microfilms (g)']].applymap(to_flow)
df4 = df4[df4.columns[4:]]
_ = df4.plot(kind="barh", stacked=True).legend(loc='upper center',␣
 ↪bbox_to_anchor=(0.1, -0.05),
          fancybox=True, shadow=True, ncol=2)
plt.title("Microplastics in lifetime ingestion water ($g$)")
_ = plt.ylabel("")
plt.savefig("images/fig9.png",dpi=400)
```



[39]:
```
df[['Microfibres (g)']] = df[['Microfibres']].applymap(compute_grams_MFB)
df[['Microfragments (g)']] = df[['Microfragments']].applymap(compute_grams_MFG)
df[['Micropellets (g)']] = df[['Micropellets']].applymap(compute_grams_MPL)
df[['Microfilms (g)']] = df[['Microfilms']].applymap(compute_grams_MFL)
```

[40]:
```
df.columns
```

[40]:
```
Index(['Data prelevare', 'Data Analiza', 'Statie', 'Sezon', 'Dimensiune (cm)',
       'M1 (g)', 'M2', 'M3', 'Substrat', 'Temp', 'Temp std', 'Sal', 'Sal std',
       'MFB-TA', 'MFB-N', 'MFB-Ab', 'MFB-Re', 'MFB-Vr', 'MFG-AT-W', 'MFG-AT-h',
       'MFG-N-W', 'MFG-N-h', 'MFG-Ab-W', 'MFG-Ab-h', 'MFG-RE-w', 'MFG-RD-h',
       'MFG-Vr-W', 'MFG-Vr-h', 'MPL-TA', 'MPL-N', 'MPL-Ab', 'MPL-RE', 'MPL-Ve',
       'MFL-TA-W', 'MFL-TA-h', 'MFL-N-W', 'MFL-N-H', 'MFL-Ab-W', 'MFL-Ab-H',
       'MFL-RE-W', 'MFL-RE-H', 'MFL-Vr-W', 'MFL-VR-H', 'Varsta [ani]',
       'mass [g]', 'debit [m3/year]', 'Season', 'Substrate', 'Latitude',
       'Longitude', 'lifetime_flow [m3]', 'Microfibres', 'Microfragments',
       'Micropellets', 'Microfilms', 'Microfibres (g)', 'Microfragments (g)',
       'Micropellets (g)', 'Microfilms (g)'],
      dtype='object')
```

[41]:
```
df['Microplastics (g)'] = df['Microfibres (g)'].fillna(0) + df['Microfragments␣
↪(g)'].fillna(0) + df['Micropellets (g)'].fillna(0) + df['Microfilms (g)'].
↪fillna(0)
df.to_csv("data/clean_v2.csv")
df[['Microplastics (g/lfw)']] = df[['Microplastics (g)']].applymap(to_flow)
```

[ ]:
```

```

[42]:
```
df[[df.columns[2], df.columns[4],df.columns[-1]]].groupby([df.columns[2], df.
↪columns[4]]).mean()
```

[42]:

		Microplastics (g/lfw)
Statie	Dimensiune (cm)	
2MAI	1.5	0.252168
	2.5	0.157231
	3.5	0.234187
	4.5	0.161719
	5.5	0.166657
PCT	2.5	0.246729
	3.5	0.290407
	4.5	0.384324
	5.5	0.251863
	6.5	0.219276
	7.5	0.200479
PMD	3.0	0.208424
	4.5	0.225689
	5.0	0.191922
	6.5	0.245415
	7.0	0.136498
	7.5	0.192535
PMG	2.5	0.225711
	3.5	0.185187
	4.5	0.167622
	5.5	0.182428
	6.5	0.169721

[43]:
```
qdf = df.copy()
qdf[['Latitude']] = df[['Statie']].applymap(get_station_lat)
qdf[['Longitude']] = df[['Statie']].applymap(get_station_lon)
qdf['mpw [g/m3]'] = qdf['Microplastics (g/lfw)']/qdf['lifetime_flow [m3]']
```

[44]:
```
qdf.columns
```

[44]:
```
Index(['Data prelevare', 'Data Analiza', 'Statie', 'Sezon', 'Dimensiune (cm)',
       'M1 (g)', 'M2', 'M3', 'Substrat', 'Temp', 'Temp std', 'Sal', 'Sal std',
       'MFB-TA', 'MFB-N', 'MFB-Ab', 'MFB-Re', 'MFB-Vr', 'MFG-AT-W', 'MFG-AT-h',
       'MFG-N-W', 'MFG-N-h', 'MFG-Ab-W', 'MFG-Ab-h', 'MFG-RE-w', 'MFG-RD-h',
       'MFG-Vr-W', 'MFG-Vr-h', 'MPL-TA', 'MPL-N', 'MPL-Ab', 'MPL-RE', 'MPL-Ve',
       'MFL-TA-W', 'MFL-TA-h', 'MFL-N-W', 'MFL-N-H', 'MFL-Ab-W', 'MFL-Ab-H',
       'MFL-RE-W', 'MFL-RE-H', 'MFL-Vr-W', 'MFL-VR-H', 'Varsta [ani]',
       'mass [g]', 'debit [m3/year]', 'Season', 'Substrate', 'Latitude',
       'Longitude', 'lifetime_flow [m3]', 'Microfibres', 'Microfragments',
       'Micropellets', 'Microfilms', 'Microfibres (g)', 'Microfragments (g)',
       'Micropellets (g)', 'Microfilms (g)', 'Microplastics (g)',
       'Microplastics (g/lfw)', 'mpw [g/m3]'],
```

```
dtype='object')
```

[45]:
```
ddf = qdf[['Statie','Substrate','Latitude','Longitude','mass␣
↪[g]','Microfibres','Microfragments','Micropellets','Microfilms','mpw [g/
↪m3]']]
```

[ ]:
```

```

[46]:
```
qdf['mpw [g/m3]'].describe()
qdf.to_csv('data/step2.csv')
```

[47]:
```
qdf.columns
fdf = qdf[['Statie','Latitude','Longitude','Substrate','mass␣
↪[g]','Microfibres','Microfragments','Micropellets','Microfilms', 'mpw [g/
↪m3]']]
```

[48]:
```
df4reg = fdf.groupby(['Statie','Substrate','Latitude','Longitude','mass [g]'],␣
↪as_index=False).agg(['mean','std'])
df4reg.to_csv("data/raw_model_data.csv")
```

[49]:
```
fdf.groupby(['Statie','Substrate','Latitude','Longitude','mass [g]']).
↪agg(['mean','std'])
```

[49]:
```
Microfibres
mean
Statie Substrate                          Latitude  Longitude mass [g]
2MAI   calcareous rock substrate          43.779532 28.582378 0.523878
894.409400  \
                                                              1.417125
572.518629
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
526.049805
                                                              2.058483
566.096613
                                                              2.385149
573.597671
                                                              2.855460
586.714205
PCT    harbour concrete quay wall         44.160792 28.657107 1.417125
603.923121
                                                              2.385149
784.757097
                                                              2.855460
625.357429
                                                              4.448892
618.494474
       ship's hull                        44.160792 28.657107 2.058483
```

```
999.933968
                                                                4.448892
696.386136
                                                                8.666064
707.489016
PMD    harbour concrete quay wall          44.342436 28.681631 1.785430
627.048750
                                                                2.385149
800.492899
                                                                2.553346
527.943617
                                                                4.448892
840.501290
                                                                6.115365
377.040473
                                                                8.666064
663.098649
PMG    cement block cliff                  43.807017 28.582175 1.417125
676.341477
                                                                2.855460
647.051250
                                                                4.448892
600.448605
       pontoon plastic floats              43.807017 28.582175 1.417125
608.598557
                                                                2.058483
648.204591
                                                                2.385149
560.189267


 std
Statie Substrate                           Latitude  Longitude mass [g]
2MAI   calcareous rock substrate           43.779532 28.582378 0.523878
574.124475  \
                                                                1.417125
534.001999
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
595.855183
                                                                2.058483
596.058346
                                                                2.385149
681.243813
                                                                2.855460
522.238822
PCT    harbour concrete quay wall          44.160792 28.657107 1.417125
663.210193
```

```
                                                                  2.385149
728.434057
                                                                  2.855460
481.973634
                                                                  4.448892
586.842867
       ship's hull                          44.160792 28.657107 2.058483
1016.960625
                                                                  4.448892
610.145817
                                                                  8.666064
700.813406
PMD    harbour concrete quay wall           44.342436 28.681631 1.785430
606.899581
                                                                  2.385149
576.254840
                                                                  2.553346
554.759555
                                                                  4.448892
793.608235
                                                                  6.115365
281.480313
                                                                  8.666064
799.537330
PMG    cement block cliff                   43.807017 28.582175 1.417125
454.231839
                                                                  2.855460
511.174791
                                                                  4.448892
482.811637
       pontoon plastic floats               43.807017 28.582175 1.417125
485.762726
                                                                  2.058483
766.902256
                                                                  2.385149
445.382593

Microfragments
  mean
Statie Substrate                            Latitude  Longitude mass [g]
2MAI   calcareous rock substrate             43.779532 28.582378 0.523878
0.000000  \
                                                                  1.417125
44.436339
       pontoon metal pillars/plastic ropes  43.779532 28.582378 1.417125
88.853241
                                                                  2.058483
```

```
121.910729
                                                                2.385149
0.000000
                                                                2.855460
34.554768
PCT    harbour concrete quay wall          44.160792 28.657107 1.417125
444.649675
                                                                2.385149
389.740573
                                                                2.855460
808.393983
                                                                4.448892
95.994221
       ship's hull                         44.160792 28.657107 2.058483
236.459251
                                                                4.448892
17.611161
                                                                8.666064
28.155185
PMD    harbour concrete quay wall          44.342436 28.681631 1.785430
881.270463
                                                                2.385149
0.000000
                                                                2.553346
0.000000
                                                                4.448892
235.284913
                                                                6.115365
1.174027
                                                                8.666064
155.513992
PMG    cement block cliff                  43.807017 28.582175 1.417125
8.893377
                                                                2.855460
0.000000
                                                                4.448892
12.020118
       pontoon plastic floats              43.807017 28.582175 1.417125
346.341330
                                                                2.058483
43.622926
                                                                2.385149
163.431185


 std
Statie Substrate                           Latitude  Longitude mass [g]
```

```
2MAI   calcareous rock substrate          43.779532 28.582378 0.523878
0.000000  \
                                                              1.417125
330.852583
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
966.506481
                                                              2.058483
911.682087
                                                              2.385149
0.000000
                                                              2.855460
324.152459
PCT    harbour concrete quay wall         44.160792 28.657107 1.417125
1914.478090
                                                              2.385149
2319.941684
                                                              2.855460
2492.534001
                                                              4.448892
438.863445
       ship's hull                        44.160792 28.657107 2.058483
706.272089
                                                              4.448892
224.765043
                                                              8.666064
155.847065
PMD    harbour concrete quay wall         44.342436 28.681631 1.785430
3525.081850
                                                              2.385149
0.000000
                                                              2.553346
0.000000
                                                              4.448892
1177.425083
                                                              6.115365
14.282655
                                                              8.666064
991.617068
PMG    cement block cliff                 43.807017 28.582175 1.417125
83.427274
                                                              2.855460
0.000000
                                                              4.448892
136.522295
       pontoon plastic floats             43.807017 28.582175 1.417125
3567.430570
                                                              2.058483
```

```
606.756462
                                                                  2.385149
899.160524

Micropellets
mean
Statie Substrate                           Latitude  Longitude mass [g]
2MAI   calcareous rock substrate           43.779532 28.582378 0.523878
0.000000  \
                                                                  1.417125
0.000000
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
0.228774
                                                                  2.058483
0.000000
                                                                  2.385149
0.000000
                                                                  2.855460
0.000000
PCT    harbour concrete quay wall          44.160792 28.657107 1.417125
0.265177
                                                                  2.385149
0.000000
                                                                  2.855460
0.000000
                                                                  4.448892
0.772895
       ship's hull                         44.160792 28.657107 2.058483
0.000000
                                                                  4.448892
0.000000
                                                                  8.666064
0.000000
PMD    harbour concrete quay wall          44.342436 28.681631 1.785430
0.000000
                                                                  2.385149
0.000000
                                                                  2.553346
0.000000
                                                                  4.448892
0.000000
                                                                  6.115365
0.000000
                                                                  8.666064
0.000000
PMG    cement block cliff                  43.807017 28.582175 1.417125
0.000000
```

```
                                                                  2.855460
0.000000
                                                                  4.448892
0.000000
       pontoon plastic floats              43.807017 28.582175 1.417125
0.000000
                                                                  2.058483
0.335566
                                                                  2.385149
0.000000


std
Statie Substrate                           Latitude  Longitude mass [g]
2MAI   calcareous rock substrate           43.779532 28.582378 0.523878
0.000000  \
                                                                  1.417125
0.000000
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
4.591018
                                                                  2.058483
0.000000
                                                                  2.385149
0.000000
                                                                  2.855460
0.000000
PCT    harbour concrete quay wall          44.160792 28.657107 1.417125
3.148806
                                                                  2.385149
0.000000
                                                                  2.855460
0.000000
                                                                  4.448892
4.764443
       ship's hull                         44.160792 28.657107 2.058483
0.000000
                                                                  4.448892
0.000000
                                                                  8.666064
0.000000
PMD    harbour concrete quay wall          44.342436 28.681631 1.785430
0.000000
                                                                  2.385149
0.000000
                                                                  2.553346
0.000000
                                                                  4.448892
```

```
0.000000
                                                                  6.115365
0.000000
                                                                  8.666064
0.000000
PMG    cement block cliff                 43.807017 28.582175 1.417125
0.000000
                                                                  2.855460
0.000000
                                                                  4.448892
0.000000
       pontoon plastic floats             43.807017 28.582175 1.417125
0.000000
                                                                  2.058483
5.984000
                                                                  2.385149
0.000000

Microfilms
mean
Statie Substrate                          Latitude  Longitude mass [g]
2MAI   calcareous rock substrate          43.779532 28.582378 0.523878
0.000000  \
                                                                  1.417125
0.000000
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
17.355802
                                                                  2.058483
391.148740
                                                                  2.385149
0.000000
                                                                  2.855460
0.000000
PCT    harbour concrete quay wall         44.160792 28.657107 1.417125
333.242816
                                                                  2.385149
830.591626
                                                                  2.855460
259.251349
                                                                  4.448892
0.000000
       ship's hull                        44.160792 28.657107 2.058483
0.000000
                                                                  4.448892
151.399393
                                                                  8.666064
0.000000
```

```
PMD    harbour concrete quay wall          44.342436 28.681631 1.785430
0.000000
                                                               2.385149
0.000000
                                                               2.553346
239.987634
                                                               4.448892
0.000000
                                                               6.115365
168.000447
                                                               8.666064
0.000000
PMG    cement block cliff                  43.807017 28.582175 1.417125
0.000000
                                                               2.855460
0.000000
                                                               4.448892
0.000000
       pontoon plastic floats              43.807017 28.582175 1.417125
301.446406
                                                               2.058483
0.000000
                                                               2.385149
21.266098


 std
Statie Substrate                           Latitude  Longitude mass [g]
2MAI   calcareous rock substrate           43.779532 28.582378 0.523878
0.000000  \
                                                               1.417125
0.000000
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
411.811904
                                                               2.058483
3928.028012
                                                               2.385149
0.000000
                                                               2.855460
0.000000
PCT    harbour concrete quay wall          44.160792 28.657107 1.417125
3542.003403
                                                               2.385149
6540.085002
                                                               2.855460
1533.751662
                                                               4.448892
```

```
0.000000
       ship's hull                          44.160792 28.657107 2.058483
0.000000
                                                                4.448892
2657.048561
                                                                8.666064
0.000000
PMD    harbour concrete quay wall           44.342436 28.681631 1.785430
0.000000
                                                                2.385149
0.000000
                                                                2.553346
1645.272327
                                                                4.448892
0.000000
                                                                6.115365
2043.813652
                                                                8.666064
0.000000
PMG    cement block cliff                   43.807017 28.582175 1.417125
0.000000
                                                                2.855460
0.000000
                                                                4.448892
0.000000
       pontoon plastic floats               43.807017 28.582175 1.417125
2954.065061
                                                                2.058483
0.000000
                                                                2.385149
351.373602

                                                                         mpw
[g/m3]
mean
Statie Substrate                            Latitude  Longitude mass [g]
2MAI   calcareous rock substrate            43.779532 28.582378 0.523878
0.316509  \
                                                                1.417125
0.044183
       pontoon metal pillars/plastic ropes  43.779532 28.582378 1.417125
0.042069
                                                                2.058483
0.030355
                                                                2.385149
0.013476
                                                                2.855460
```

```
0.008937
PCT    harbour concrete quay wall          44.160792 28.657107 1.417125
0.066874
                                                               2.385149
0.032026
                                                               2.855460
0.013506
                                                               4.448892
0.004856
       ship's hull                         44.160792 28.657107 2.058483
0.037642
                                                               4.448892
0.006053
                                                               8.666064
0.002206
PMD    harbour concrete quay wall          44.342436 28.681631 1.785430
0.036905
                                                               2.385149
0.018807
                                                               2.553346
0.013074
                                                               4.448892
0.006628
                                                               6.115365
0.002386
                                                               8.666064
0.002119
PMG    cement block cliff                  43.807017 28.582175 1.417125
0.051771
                                                               2.855460
0.009783
                                                               4.448892
0.004583
       pontoon plastic floats              43.807017 28.582175 1.417125
0.064542
                                                               2.058483
0.024003
                                                               2.385149
0.013968


std
Statie Substrate                           Latitude  Longitude mass [g]
2MAI   calcareous rock substrate           43.779532 28.582378 0.523878
0.203168
                                                               1.417125
0.042451
```

```
       pontoon metal pillars/plastic ropes 43.779532 28.582378 1.417125
0.057461
                                                                  2.058483
0.101666
                                                                  2.385149
0.016005
                                                                  2.855460
0.007976
PCT    harbour concrete quay wall          44.160792 28.657107 1.417125
0.192361
                                                                  2.385149
0.102511
                                                                  2.855460
0.023080
                                                                  4.448892
0.004845
       ship's hull                         44.160792 28.657107 2.058483
0.038888
                                                                  4.448892
0.014217
                                                                  8.666064
0.002205
PMD    harbour concrete quay wall          44.342436 28.681631 1.785430
0.046672
                                                                  2.385149
0.013539
                                                                  2.553346
0.025252
                                                                  4.448892
0.006762
                                                                  6.115365
0.006979
                                                                  8.666064
0.002731
PMG    cement block cliff                  43.807017 28.582175 1.417125
0.034864
                                                                  2.855460
0.007728
                                                                  4.448892
0.003697
       pontoon plastic floats              43.807017 28.582175 1.417125
0.173034
                                                                  2.058483
0.031217
                                                                  2.385149
0.013516
```

[50]:
```
# normam la gramul de midie umeda
fdf.columns[-5:]
df2 = fdf.copy()
for col in fdf.columns[-5:]:
    df2[col] = df2[col]/df2['mass [g]']
# df2 contine datele de intrare normata la gramul de midie umeda
df2
```

[50]:

	Statie	Latitude	Longitude	Substrate	mass [g]	\
0	2MAI	43.779532	28.582378	calcareous rock substrate	1.417125	\
1	2MAI	43.779532	28.582378	calcareous rock substrate	1.417125	
2	2MAI	43.779532	28.582378	calcareous rock substrate	1.417125	
3	2MAI	43.779532	28.582378	calcareous rock substrate	1.417125	
4	2MAI	43.779532	28.582378	calcareous rock substrate	1.417125	
…	…	…	…	…	…	
3434	PMG	43.807017	28.582175	pontoon plastic floats	2.385149	
3435	PMG	43.807017	28.582175	pontoon plastic floats	2.385149	
3436	PMG	43.807017	28.582175	pontoon plastic floats	2.385149	
3437	PMG	43.807017	28.582175	pontoon plastic floats	2.385149	
3438	PMG	43.807017	28.582175	pontoon plastic floats	2.385149	

	Microfibres	Microfragments	Micropellets	Microfilms	mpw [g/m3]
0	692.691220	1624.928222	0.0	0.0	0.068744
1	1629.940977	691.653062	0.0	0.0	0.131286
2	1402.536891	0.000000	0.0	0.0	0.107178
3	1138.128305	0.000000	0.0	0.0	0.086973
4	337.733102	0.000000	0.0	0.0	0.025809
…	…	…	…	…	…
3434	228.878769	0.000000	0.0	0.0	0.005377
3435	404.586859	0.000000	0.0	0.0	0.009505
3436	367.134275	0.000000	0.0	0.0	0.008626
3437	287.600464	0.000000	0.0	0.0	0.006757
3438	0.000000	0.000000	0.0	0.0	0.000000

[3439 rows x 10 columns]

[51]:
```
df3 = df2.drop(['mass [g]'], axis=1).
↪groupby(["Statie",'Substrate',"Latitude","Longitude"]).agg(['mean','std'])
```

[52]:
```
df3.to_csv("data/station_means.csv")
```

[53]:
```
df3
```

[53]:

				Microfibres
				mean
Statie	Substrate	Latitude	Longitude	
2MAI	calcareous rock substrate	43.779532	28.582378	667.822967 \

```
       pontoon metal pillars/plastic ropes 43.779532 28.582378  325.031900
PCT    harbour concrete quay wall          44.160792 28.657107  338.535428
       ship's hull                         44.160792 28.657107  193.968360
PMD    harbour concrete quay wall          44.342436 28.681631  156.238181
PMG    cement block cliff                  43.807017 28.582175  258.493144
       pontoon plastic floats              43.807017 28.582175  322.463377


                                                                      std
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378  792.281618  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378  373.928457
PCT    harbour concrete quay wall          44.160792 28.657107  386.433143
       ship's hull                         44.160792 28.657107  254.265161
PMD    harbour concrete quay wall          44.342436 28.681631  193.612496
PMG    cement block cliff                  43.807017 28.582175  250.203728
       pontoon plastic floats              43.807017 28.582175  322.964585

                                                                Microfragments
                                                                          mean
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378     25.009177  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378     52.066378
PCT    harbour concrete quay wall          44.160792 28.657107    235.873150
       ship's hull                         44.160792 28.657107     20.033023
PMD    harbour concrete quay wall          44.342436 28.681631     30.126782
PMG    cement block cliff                  43.807017 28.582175      2.806206
       pontoon plastic floats              43.807017 28.582175    102.230274


                                                                       std
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378   208.776873  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378   573.752352
PCT    harbour concrete quay wall          44.160792 28.657107  1115.989336
       ship's hull                         44.160792 28.657107   142.606074
PMD    harbour concrete quay wall          44.342436 28.681631   403.056044
PMG    cement block cliff                  43.807017 28.582175    36.397834
       pontoon plastic floats              43.807017 28.582175  1394.698037

                                                                 Micropellets
                                                                         mean
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378     0.000000  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378     0.099877
PCT    harbour concrete quay wall          44.160792 28.657107     0.119515
       ship's hull                         44.160792 28.657107     0.000000
```

```
PMD    harbour concrete quay wall          44.342436 28.681631     0.000000
PMG    cement block cliff                  43.807017 28.582175     0.000000
       pontoon plastic floats              43.807017 28.582175     0.061934


                                                                       std
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378  0.000000  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378  2.548549
PCT    harbour concrete quay wall          44.160792 28.657107  1.635711
       ship's hull                         44.160792 28.657107  0.000000
PMD    harbour concrete quay wall          44.342436 28.681631  0.000000
PMG    cement block cliff                  43.807017 28.582175  0.000000
       pontoon plastic floats              43.807017 28.582175  1.791823

                                                                Microfilms
                                                                      mean
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378    0.000000  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378   46.415944
PCT    harbour concrete quay wall          44.160792 28.657107  209.873139
       ship's hull                         44.160792 28.657107   24.262705
PMD    harbour concrete quay wall          44.342436 28.681631   20.392645
PMG    cement block cliff                  43.807017 28.582175    0.000000
       pontoon plastic floats              43.807017 28.582175   65.427043


                                                                         std
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378     0.000000  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378   893.649658
PCT    harbour concrete quay wall          44.160792 28.657107  2212.764726
       ship's hull                         44.160792 28.657107   504.290845
PMD    harbour concrete quay wall          44.342436 28.681631   294.005865
PMG    cement block cliff                  43.807017 28.582175     0.000000
       pontoon plastic floats              43.807017 28.582175  1135.592819

                                                               mpw [g/m3]
                                                                      mean
Statie Substrate                           Latitude  Longitude
2MAI   calcareous rock substrate           43.779532 28.582378   0.147167  \
       pontoon metal pillars/plastic ropes 43.779532 28.582378   0.022136
PCT    harbour concrete quay wall          44.160792 28.657107   0.027874
       ship's hull                         44.160792 28.657107   0.003673
PMD    harbour concrete quay wall          44.342436 28.681631   0.003086
PMG    cement block cliff                  43.807017 28.582175   0.011539
       pontoon plastic floats              43.807017 28.582175   0.019726
```

				std
Statie	Substrate	Latitude	Longitude	
2MAI	calcareous rock substrate	43.779532	28.582378	0.289647
	pontoon metal pillars/plastic ropes	43.779532	28.582378	0.040256
PCT	harbour concrete quay wall	44.160792	28.657107	0.101014
	ship's hull	44.160792	28.657107	0.009763
PMD	harbour concrete quay wall	44.342436	28.681631	0.007891
PMG	cement block cliff	43.807017	28.582175	0.020122
	pontoon plastic floats	43.807017	28.582175	0.068925

[54]:
```
df3[df3.columns[:2]].filter(like='PMG',axis=0)
```

[54]:

				Microfibres	
				mean	std
Statie	Substrate	Latitude	Longitude		
PMG	cement block cliff	43.807017	28.582175	258.493144	250.203728
	pontoon plastic floats	43.807017	28.582175	322.463377	322.964585

[55]:
```
station_map = {
    0:'2MAI',
    1:'PCT',
    2:'PMD',
    3:'PMG'}

substrate_map = {
    0:"Calcareous rock substrate",
    1:"pontoon metal pillars / plastic ropes",
    2:"Ship's hull",
    3:"harbor concrete quay wall",
    4:"Cement block cliff",
    5:"pontoon plastic floats"}

substrates = {
    "2MAI":["Calcareous rock substrate","pontoon metal pillars / plastic␣
 ↪ropes"],
    "PCT": ["Ship's hull","harbor concrete quay wall"],
    "PMD": ["harbor concrete quay wall"],
    "PMG": ["Cement block cliff","pontoon plastic floats"]
}
stations = ["2MAI","PCT","PMD","PMG"]
```

[56]:
```
def synth_microfibers(station, substrate, mass=1):
    if not station in stations:
        raise Exception("Invalid station")
    if not substrate in substrates[station]:
```

```
        raise Exception("Invalid substrate")
    rt = df3.loc[
        (df3.index.get_level_values(0) == station) &
        (df3.index.get_level_values(1) == substrate)]['Microfibers'].values
    r = np.random.normal(loc=rt[0][0], scale=rt[0][1])
    return mass*r if r > 0 else [0]

def synth_microfragments(station, substrate, mass=1):
    if not station in stations:
        raise Exception("Invalid station")
    if not substrate in substrates[station]:
        raise Exception("Invalid substrate")
    rt = df3.loc[
        (df3.index.get_level_values(0) == station) &
        (df3.index.get_level_values(1) == substrate)]['Microfragments'].values
    r = np.random.normal(loc=rt[0][0], scale=rt[0][1])
    return mass*r if r > 0 else [0]

def synth_micropelets(station, substrate, mass=1):
    if not station in stations:
        raise Exception("Invalid station")
    if not substrate in substrates[station]:
        raise Exception("Invalid substrate")
    rt = df3.loc[
        (df3.index.get_level_values(0) == station) &
        (df3.index.get_level_values(1) == substrate)]['Micropelets'].values
    r = np.random.normal(loc=rt[0][0], scale=rt[0][1])
    return mass*r if r > 0 else [0]

def synth_microfilms(station, substrate, mass=1):
    if not station in stations:
        raise Exception("Invalid station")
    if not substrate in substrates[station]:
        raise Exception("Invalid substrate")
    rt = df3.loc[
        (df3.index.get_level_values(0) == station) &
        (df3.index.get_level_values(1) == substrate)]['Microfilms'].values
    r = np.random.normal(loc=rt[0][0], scale=rt[0][1])
    return mass*r if r > 0 else [0]
```

[57]:
```
# synth_microfilms('PCT',"Ship's hull")
# df3[['Microfibers (g)']] = df3[['Microfibers']].applymap(compute_grams_MFB)
# df3[['Microfragments (g)']] = df3[['Microfragments']].
  ↪applymap(compute_grams_MFG)
# df3[['Micropelets (g)']] = df3[['Micropelets']].applymap(compute_grams_MPL)
# df3[['Microfilms (g)']] = df3[['Microfilms']].applymap(compute_grams_MFL)
```

[58]:
```
def sample_stations():
    p = np.poly1d([ 0.02171418, -0.27103738,  1.0708402 , -0.80818823,  0.
 ↪13159321])
    dim = np.random.normal(loc=4.1768, scale=2.5192,size=1)
    mass = p(dim)
    st = np.random.choice(stations,size=1)[0]
    su = np.random.choice(substrates[st],size=1)[0]
    result =  {
        'Statie': st,
        'Substrate':su,
        'Longitude':get_station_lon(st),
        'Latitude':get_station_lat(st),
        'Size':dim[0],
        'Microfibers':synth_microfibers(st,su,mass)[0],
        'Microfragments':synth_microfragments(st,su,mass)[0],
        'Micropelets':synth_micropelets(st,su,mass)[0],
        'Microfilms':synth_microfilms(st,su,mass)[0]}
    upl = compute_grams_MFB(result['Microfibers'])
    upl = upl + compute_grams_MFG(result['Microfragments'])
    upl = upl + compute_grams_MPL(result['Micropelets'])
    upl = upl + compute_grams_MFL(result['Microfilms'])
    upl = upl/0.013
    age = inverse_growth_fit(10*dim)
    result['age'] = age[0]
    waterflow = (age*365*24*mass*.3)/1000
    result['mpw'] = upl/waterflow[0]
    return result
```

[59]:
```
df['Dimensiune (cm)'].mean(), df['Dimensiune (cm)'].std()
```

[59]:
```
(4.176795580110498, 1.7191144113483687)
```

[60]:
```
#lst = []
#for i in range(int(1e5)):
#    try:
#        lst.append(sample_stations())
#    except:
##        pass
#sdf = pd.DataFrame(lst)
```

[61]:
```
sdf
```

```
---------------------------------------------------------------------------
NameError                                 Traceback (most recent call last)
Cell In[61], line 1
----> 1 sdf
```

```
NameError: name 'sdf' is not defined
```

[ ]:
```
df3.to_latex()
```

[ ]:
```
import sys
sys.version
```