In [1]:

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import missingno as mno
from sklearn import linear_model
%matplotlib inline
```

Delos Data Test

In this notebook ill be working on delos data test to try to explain how parameters (TAN ppm, Phosphate ppm, Phytoplankton density) changes over time.

There will be two parts in this notebook :

1. Quick look and Data Preparation.
2. Exploratory Data Analysis

Quick look and Data Preparation

In [2]:

```
df = pd.read_csv('delos.csv', thousands=',')
df.head()
```

Out[2]:

	Days of production	Pond Identifier	Temperature in the Morning	Temperature n the Afternoon	Temperature in the Evening	Feed per day (kg of shrimp feed)	TAN ppm	Phosphate ppm	Ph
0	1	A1	29	30	29	3.5	NaN	NaN	
1	2	A1	30	32	29	3.5	NaN	NaN	
2	3	A1	29	33	31	4	0.606	0.036	
3	4	A1	29	32	31	4	NaN	NaN	
4	5	A1	30	30	28	4.5	NaN	NaN	

Renaming Columns name so it is easier to work with.

In [3]:

```
df.rename(columns = {'Days of production' : 'Days of Production',
                     'Pond Identifier' : 'Pond ID',
                     'Temperature in the Morning' : 'Morning Temp',
                     'Temperature n the Afternoon' : 'Afternoon Temp',
                     'Temperature in the Evening' : 'Evening Temp',
                     'Feed per day (kg of shrimp feed)' : 'Feed/Day in Kg'}, inplace=True)
```

In [4]:

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 889 entries, 0 to 888
Data columns (total 9 columns):
 #   Column                  Non-Null Count  Dtype  
---  ------                  --------------  -----  
 0   Days of Production      889 non-null    int64  
 1   Pond ID                 889 non-null    object 
 2   Morning Temp            889 non-null    int64  
 3   Afternoon Temp          889 non-null    object 
 4   Evening Temp            889 non-null    object 
 5   Feed/Day in Kg          889 non-null    object 
 6   TAN ppm                 248 non-null    float64
 7   Phosphate ppm           248 non-null    float64
 8   Phytoplankton cells/ml  248 non-null    float64
dtypes: float64(3), int64(2), object(4)
memory usage: 62.6+ KB
```

Assigning appropriate data type to each columns.

In [5]:

```
def isnumber(x):
    try:
        float(x)
        return True
    except:
        return False
```

In [6]:

```
df2 = df.copy()
df2 = df2[df2.applymap(isnumber)]
df2 = df2.applymap(float)
df2['Pond ID'] = df['Pond ID']
df2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 889 entries, 0 to 888
Data columns (total 9 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Days of Production     889 non-null    float64
 1   Pond ID                889 non-null    object 
 2   Morning Temp           889 non-null    float64
 3   Afternoon Temp         886 non-null    float64
 4   Evening Temp           886 non-null    float64
 5   Feed/Day in Kg         804 non-null    float64
 6   TAN ppm                248 non-null    float64
 7   Phosphate ppm          248 non-null    float64
 8   Phytoplankton cells/ml  248 non-null    float64
dtypes: float64(8), object(1)
memory usage: 62.6+ KB
```

In [7]:

```
df2[df2['Afternoon Temp'].isnull()]
```

Out[7]:

	Days of Production	Pond ID	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytoplanktc cells/r
76	77.0	A1	27.0	NaN	NaN	NaN	NaN	NaN	Na
247	77.0	A3	28.0	NaN	NaN	5.0	NaN	NaN	Na
700	77.0	A8	27.0	NaN	NaN	NaN	NaN	NaN	Na

There are few missing data on 'Afternoon Temp' and 'Evening Temp' and quite a lot on 'Feed/Day in Kg'

First, i will be imputing the missing data on Temperature columns, and i will be imputing the data with the average temperature changes through out the day, to do that, ill be creating new column representing changes between each measurement, Morning to Afternoon (Temp Change to Afternoon) and Afternoon to Evening (Temp Change to Evening) then find the average, sum the newly created value to previous temperature measurement (adding Temp Change to afternoon to Morning temp value, Temp Change to Evening to Afternoon temp value) to impute the missing temperature measurement.

Note : im rounding the average changes so the result follow suit to the rest of measurement.

In [8]:

```
df2['Days of Production'] = df2['Days of Production'].astype('int64')
df2['Morning Temp'] = df2['Morning Temp'].astype('int64')
df2['Temp Change to Afternoon'] = df2['Afternoon Temp'] - df2['Morning Temp']
df2['Temp Change to Evening'] = df2['Evening Temp'] - df2['Afternoon Temp']
df2.head()
```

Out[8]:

	Days of Production	Pond ID	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytoplankton cells/ml
0	1	A1	29	30.0	29.0	3.5	NaN	NaN	NaN
1	2	A1	30	32.0	29.0	3.5	NaN	NaN	NaN
2	3	A1	29	33.0	31.0	4.0	0.606	0.036	3000.0
3	4	A1	29	32.0	31.0	4.0	NaN	NaN	NaN
4	5	A1	30	30.0	28.0	4.5	NaN	NaN	NaN

In [9]:

```
df2['Temp Change to Afternoon'].mean(skipna = True)
```

Out[9]:

```
1.744920993227991
```

In [10]:

```
df2[df2['Days of Production'] == 77]
```

Out[10]:

	Days of Production	Pond ID	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytoplankto cells/r
76	77	A1	27	NaN	NaN	NaN	NaN	NaN	Na
153	77	A2	28	29.0	29.0	5.0	NaN	NaN	Na
247	77	A3	28	NaN	NaN	5.0	NaN	NaN	Na
324	77	A4	27	29.0	29.0	5.0	NaN	NaN	Na
418	77	A5	28	29.0	29.0	5.0	NaN	NaN	Na
512	77	A6	27	29.0	29.0	5.0	NaN	NaN	Na
606	77	A7	27	29.0	29.0	5.0	NaN	NaN	Na
700	77	A8	27	NaN	NaN	NaN	NaN	NaN	Na
777	77	A9	28	29.0	29.0	5.0	NaN	NaN	Na
871	77	AA10	27	29.0	29.0	5.0	NaN	NaN	Na

In [11]:

```
avg2728 = df2[df2['Morning Temp'].isin([27, 28])]
avg2728['Temp Change to Afternoon'].mean(skipna=True)
```

Out[11]:

```
1.7420382165605095
```

In [12]:

```
noon_offset = round(df2['Temp Change to Afternoon'].mean(skipna = True))
df2['Afternoon Temp'].fillna(value = df2['Morning Temp'] + noon_offset, axis = 0, inplace =
eve_offset = round(df2['Temp Change to Evening'].mean(skipna = True))
df2['Evening Temp'].fillna(value = df2['Afternoon Temp'] + eve_offset, axis = 0, inplace =
df2.drop(['Temp Change to Afternoon', 'Temp Change to Evening'], axis = 1, inplace = True)
df2['Afternoon Temp'] = df2['Afternoon Temp'].astype('int64')
df2['Evening Temp'] = df2['Evening Temp'].astype('int64')
df2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 889 entries, 0 to 888
Data columns (total 9 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   Days of Production      889 non-null    int64
 1   Pond ID                 889 non-null    object
 2   Morning Temp            889 non-null    int64
 3   Afternoon Temp          889 non-null    int64
 4   Evening Temp            889 non-null    int64
 5   Feed/Day in Kg          804 non-null    float64
 6   TAN ppm                 248 non-null    float64
 7   Phosphate ppm           248 non-null    float64
 8   Phytoplankton cells/ml  248 non-null    float64
dtypes: float64(4), int64(4), object(1)
memory usage: 62.6+ KB
```

In [13]:

```
df2[df2['Days of Production'] == 77]
```

Out[13]:

	Days of Production	Pond ID	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytoplanktc cells/r
76	77	A1	27	29	28	NaN	NaN	NaN	Na
153	77	A2	28	29	29	5.0	NaN	NaN	Na
247	77	A3	28	30	29	5.0	NaN	NaN	Na
324	77	A4	27	29	29	5.0	NaN	NaN	Na
418	77	A5	28	29	29	5.0	NaN	NaN	Na
512	77	A6	27	29	29	5.0	NaN	NaN	Na
606	77	A7	27	29	29	5.0	NaN	NaN	Na
700	77	A8	27	29	28	NaN	NaN	NaN	Na
777	77	A9	28	29	29	5.0	NaN	NaN	Na
871	77	AA10	27	29	29	5.0	NaN	NaN	Na

Now that Temperature are fully imputed, we move to imputing 'Feed/Day in Kg'. Explained in definitions, the amount of feed are affected by :

1. Feeding behaviour, which are not represented in the data
2. Observed growth, i assumed tied to days of production
3. Water conditions, which are not clear to me if its only temperature or there are other factors, also not clear if the temperature data is water temperature or not.

With the limited information given, ill be imputing it using regression estimation based on 'Days of Production' and average temperature that day. assuming the temperature represented in the data affect the amount of feed.

reason why im using average daily temperature is to avoid multicolinearity if using each temp measurement and because the amount of feed represented are accumulation through out the day. (this is my assumption, i dont think the shrimp feed are all given in one feeding session, if so, then it is more appropriate to use related temperature measurement)

note : it will be nice change if the feed amount represented as each feeding session instead of sum of daily amount.

In [14]:

```
df2['Temp Avg'] = round(df2.iloc[:,2:5].sum(axis=1) / 3)
df2.head()
```

Out[14]:

	Days of Production	Pond ID	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytoplankton cells/ml
0	1	A1	29	30	29	3.5	NaN	NaN	NaN
1	2	A1	30	32	29	3.5	NaN	NaN	NaN
2	3	A1	29	33	31	4.0	0.606	0.036	3000.0
3	4	A1	29	32	31	4.0	NaN	NaN	NaN
4	5	A1	30	30	28	4.5	NaN	NaN	NaN

In [15]:

```
from sklearn.linear_model import LinearRegression
lr = LinearRegression()
testdf = df2[df2['Feed/Day in Kg'].isnull()==True]
traindf = df2[df2['Feed/Day in Kg'].isnull()==False]
y = traindf['Feed/Day in Kg']
traindf.drop(['Feed/Day in Kg', 'TAN ppm', 'Phosphate ppm', 'Phytoplankton cells/ml', 'Pond
              'Morning Temp', 'Afternoon Temp', 'Evening Temp'],axis=1,inplace=True)
testdf.drop(['TAN ppm', 'Phosphate ppm', 'Phytoplankton cells/ml', 'Pond ID',
              'Morning Temp', 'Afternoon Temp', 'Evening Temp'],axis=1,inplace=True)
lr.fit(traindf,y)
testdf.drop('Feed/Day in Kg',axis=1,inplace=True)
pred = lr.predict(testdf)
testdf['Feed/Day in Kg']= pred
```

```
C:\Users\fadhl\anaconda3\lib\site-packages\pandas\core\frame.py:4906: Settin
gWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://pand
as.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-v
ersus-a-copy)
  return super().drop(
C:\Users\fadhl\anaconda3\lib\site-packages\pandas\core\frame.py:4906: Settin
gWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://pand
as.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-v
ersus-a-copy)
  return super().drop(
C:\Users\fadhl\AppData\Local\Temp/ipykernel_8348/1843180322.py:13: SettingWi
thCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://pand
as.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-v
ersus-a-copy)
  testdf['Feed/Day in Kg']= pred
```

In [16]:

```
testdf.head()
```

Out[16]:

	Days of Production	Temp Avg	Feed/Day in Kg
31	32	30.0	20.876204
41	42	31.0	27.537404
42	43	30.0	25.744188
50	51	30.0	29.284540
62	63	29.0	32.359308

Rounding the value to nearest .5 value to follow existing measurement.

In [17]:

```
roundedfeed = round((testdf['Feed/Day in Kg']*2))/2
```

In [18]:

```
testdf['Feed/Day in Kg'] = roundedfeed
```

```
C:\Users\fadhl\AppData\Local\Temp/ipykernel_8348/1861053242.py:1: SettingWit
hCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://pand
as.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-v
ersus-a-copy)
  testdf['Feed/Day in Kg'] = roundedfeed
```

In [19]:

```
traindf['Feed/Day in Kg'] = y
```

```
C:\Users\fadhl\AppData\Local\Temp/ipykernel_8348/1717638613.py:1: SettingWit
hCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://pand
as.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-v
ersus-a-copy)
  traindf['Feed/Day in Kg'] = y
```

In [20]:

```
traindf.head()
```

Out[20]:

	Days of Production	Temp Avg	Feed/Day in Kg
0	1	29.0	3.5
1	2	30.0	3.5
2	3	31.0	4.0
3	4	31.0	4.0
4	5	29.0	4.5

In [21]:

```
testdf.head()
```

Out[21]:

	Days of Production	Temp Avg	Feed/Day in Kg
31	32	30.0	21.0
41	42	31.0	27.5
42	43	30.0	25.5
50	51	30.0	29.5
62	63	29.0	32.5

In [22]:

```
df3 = traindf.append(testdf, ignore_index=False)
df3.tail()
```

Out[22]:

	Days of Production	Temp Avg	Feed/Day in Kg
859	65	30.0	35.5
861	67	30.0	36.5
862	68	29.0	34.5
866	72	29.0	36.5
880	86	30.0	45.0

In [23]:

```
df3.sort_index(inplace = True)
df4 = pd.merge(df3, df2[['Morning Temp', 'Afternoon Temp', 'Evening Temp', 'Pond ID',
                         'TAN ppm', 'Phosphate ppm', 'Phytoplankton cells/ml']], left_index
df4.columns
```

Out[23]:

```
Index(['Days of Production', 'Temp Avg', 'Feed/Day in Kg', 'Morning Temp',
       'Afternoon Temp', 'Evening Temp', 'Pond ID', 'TAN ppm', 'Phosphate pp
m',
       'Phytoplankton cells/ml'],
      dtype='object')
```

In [24]:

```
df4 = df4.reindex(columns = ['Days of Production', 'Pond ID', 'Temp Avg', 'Morning Temp', '
       'Feed/Day in Kg', 'TAN ppm', 'Phosphate ppm', 'Phytoplankton cells/ml'])
```

In [25]:

```
checknull = df4[df4['TAN ppm'].isnull()]
checknull.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 641 entries, 0 to 888
Data columns (total 10 columns):
 #   Column                  Non-Null Count  Dtype  
---  ------                  --------------  -----  
 0   Days of Production      641 non-null    int64  
 1   Pond ID                 641 non-null    object 
 2   Temp Avg                641 non-null    float64
 3   Morning Temp            641 non-null    int64  
 4   Afternoon Temp          641 non-null    int64  
 5   Evening Temp            641 non-null    int64  
 6   Feed/Day in Kg          641 non-null    float64
 7   TAN ppm                 0 non-null      float64
 8   Phosphate ppm           0 non-null      float64
 9   Phytoplankton cells/ml  0 non-null      float64
dtypes: float64(5), int64(4), object(1)
memory usage: 55.1+ KB
```

In [26]:

```
checknull['Days of Production'].unique()
```

Out[26]:

```
array([ 1,  2,  4,  5,  7,  8,  9, 11, 12, 14, 15, 16, 18, 19, 21, 22, 23,
       25, 26, 28, 29, 30, 32, 33, 35, 36, 37, 39, 40, 42, 43, 44, 46, 47,
       49, 50, 51, 53, 54, 56, 57, 58, 60, 61, 63, 64, 65, 67, 68, 70, 71,
       72, 74, 75, 77, 78, 79, 81, 82, 84, 85, 86, 88, 89, 91, 92, 93, 94],
      dtype=int64)
```

In [27]:

```
checknotnull = df4[df4['TAN ppm'].notnull()]
checknotnull.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 248 entries, 2 to 884
Data columns (total 10 columns):
 #   Column                  Non-Null Count  Dtype  
---  ------                  --------------  -----  
 0   Days of Production      248 non-null    int64  
 1   Pond ID                 248 non-null    object 
 2   Temp Avg                248 non-null    float64
 3   Morning Temp            248 non-null    int64  
 4   Afternoon Temp          248 non-null    int64  
 5   Evening Temp            248 non-null    int64  
 6   Feed/Day in Kg          248 non-null    float64
 7   TAN ppm                 248 non-null    float64
 8   Phosphate ppm           248 non-null    float64
 9   Phytoplankton cells/ml  248 non-null    float64
dtypes: float64(5), int64(4), object(1)
memory usage: 21.3+ KB
```

In [28]:

```
checknotnull['Days of Production'].unique()
```

Out[28]:

```
array([ 3,  6, 10, 13, 17, 20, 24, 27, 31, 34, 38, 41, 45, 48, 52, 55, 59,
       62, 66, 69, 73, 76, 80, 83, 87, 90], dtype=int64)
```

After inspecting the data further, it seems there are repeating pattern on when the parameters measurement are taken, looks like parameters are taken on 4th and 3rd day alternately (possibly monday and friday). (Excluding the first measurement if the recording start at day 1 instead of 0).

With that, ill be continuing to the analysis only using data that have parameters.

Note : by the end of this notebook, i modeled the data where i assume each parameters measurement are affected by the previous day, the data is summarized between each measurement taken, replacing 'Day of Production' to 'Measurement Order'. (ex : because the first measurement taken at day 3, data from day 1 through day 3 are summarized) reason why i dont continue the analysis using this, is because im not sure how should i summarized each variables.

Exploratory Data Analysis

After we done with the preparation, now we can start exploring the data, in this part, you will see variables in the data plotted againts the parameters to see if there are some kind relationships and hopefully to infere something out of it.

In [29]:

```
checknotnull.describe()
```

Out[29]:

	Days of Production	Temp Avg	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Ph
count	248.000000	248.000000	248.000000	248.000000	248.000000	248.000000	248.000000	24
mean	44.637097	29.471774	28.741935	30.334677	29.528226	26.635081	0.735968	
std	25.461198	1.123547	0.959681	1.299676	1.049007	14.568729	0.505391	
min	3.000000	27.000000	27.000000	27.000000	27.000000	4.000000	0.113000	
25%	24.000000	29.000000	28.000000	30.000000	29.000000	19.000000	0.334500	
50%	45.000000	30.000000	29.000000	30.000000	30.000000	26.000000	0.619500	
75%	66.000000	30.000000	29.000000	31.000000	30.000000	34.000000	0.972250	
max	90.000000	31.000000	31.000000	33.000000	31.000000	64.000000	2.774000	

In [30]:

```
checknotnull['Temp Avg'].median(), checknotnull['Temp Avg'].mode()
```

Out[30]:

```
(30.0,
 0    30.0
 dtype: float64)
```

Days of Production

Plot below are the average amount of measurement on each 'Days of Production' and each 'Pond ID'

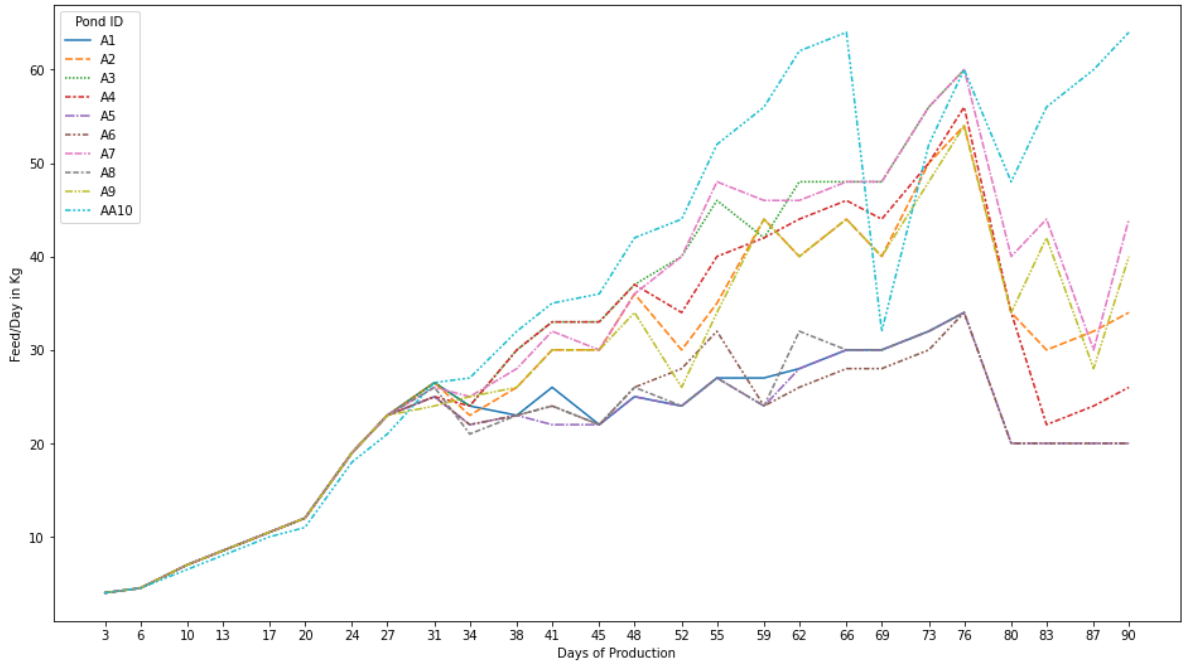
In [31]:

```
dayvsfeed = checknotnull.pivot('Days of Production', 'Pond ID', 'Feed/Day in Kg')
dayvstan = checknotnull.pivot('Days of Production', 'Pond ID', 'TAN ppm')
dayvsphos = checknotnull.pivot('Days of Production', 'Pond ID', 'Phosphate ppm')
dayvscell = checknotnull.pivot('Days of Production', 'Pond ID', 'Phytoplankton cells/ml')
```

vs Feed/Day

In [32]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = dayvsfeed)
ax.set(xticks = dayvsfeed.index)
ax.set_ylabel("Feed/Day in Kg")
plt.show()
```



Plotting 'Feed/Day in Kg' over 'Days of Production' individually per Pond ID :

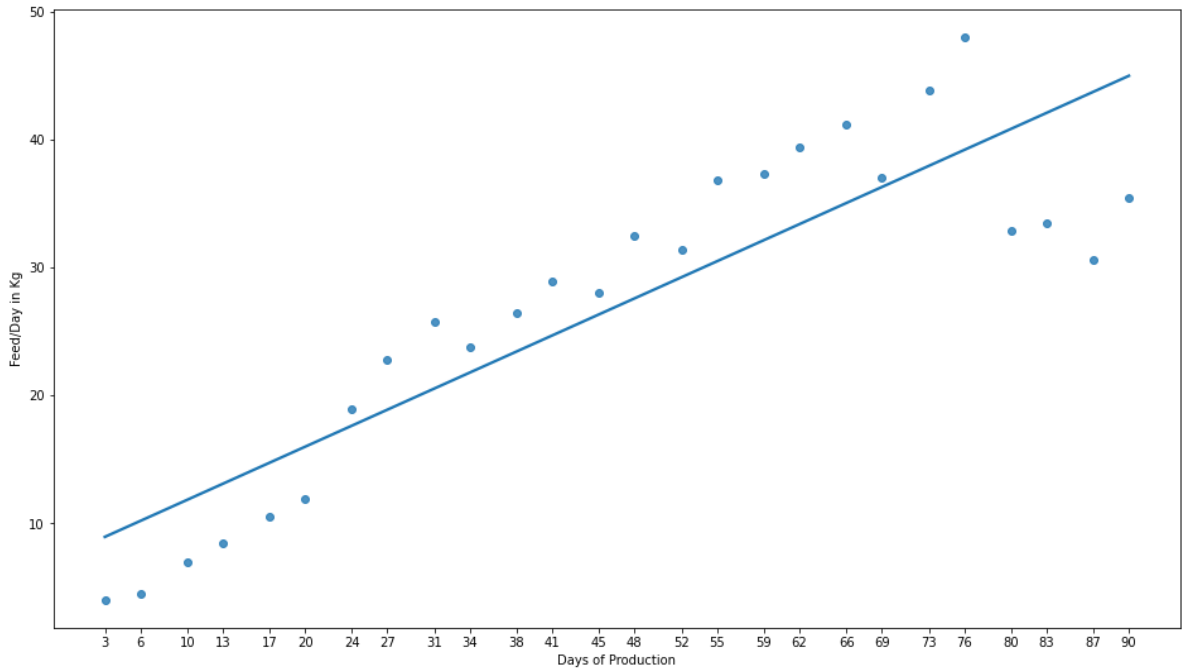
- Feeding pattern on all ponds seems to be generally the same until day 31.
- After day 31, while all the ponds feeding pattern still generally increases over time, the number and the amount of increase are more varied.

- The longer the production goes, seems the feeding pattern are more departed from its previous pattern.

aside from the stated explanation that days of production affect the amount of feed given, it seems there are other factors to each pond that also affecting amounnt of feed given.

In [33]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Days of Production', as_index=False).mean(), x='D
ax.set(xticks = checknotnull.groupby(by='Days of Production').mean().index)
plt.show()
```

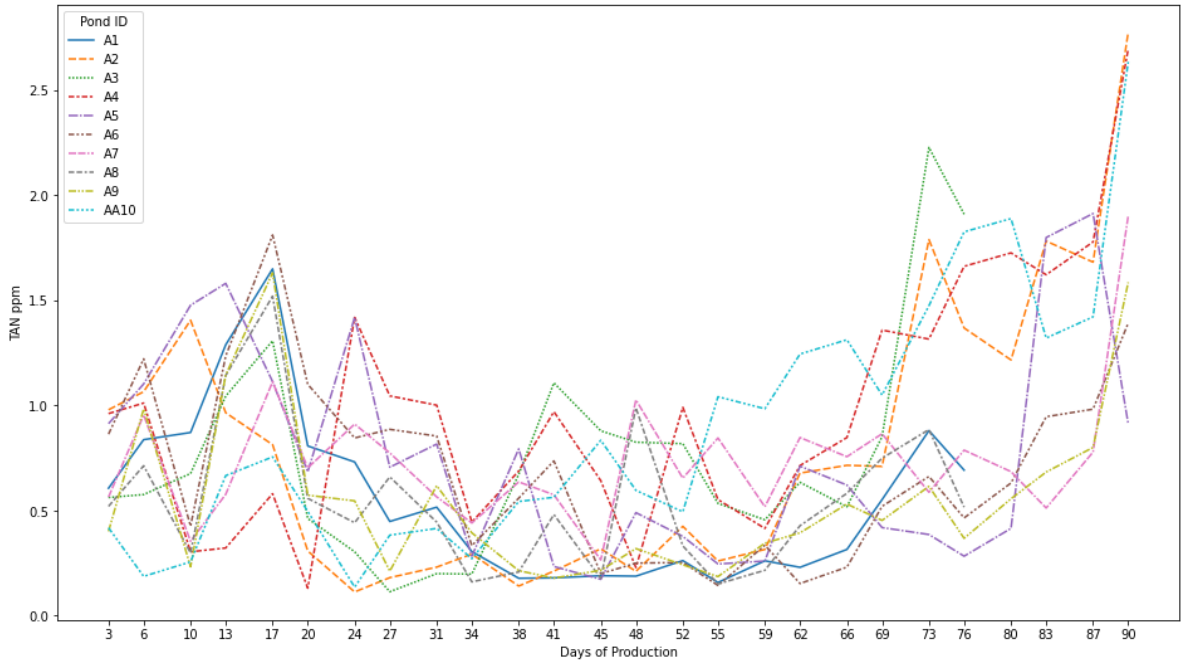


Above plot are the average of 'Feed/Day in Kg' across all ponds over 'Days of Production', as you can see, over time, the amount of feed also increases.

vs TAN ppm

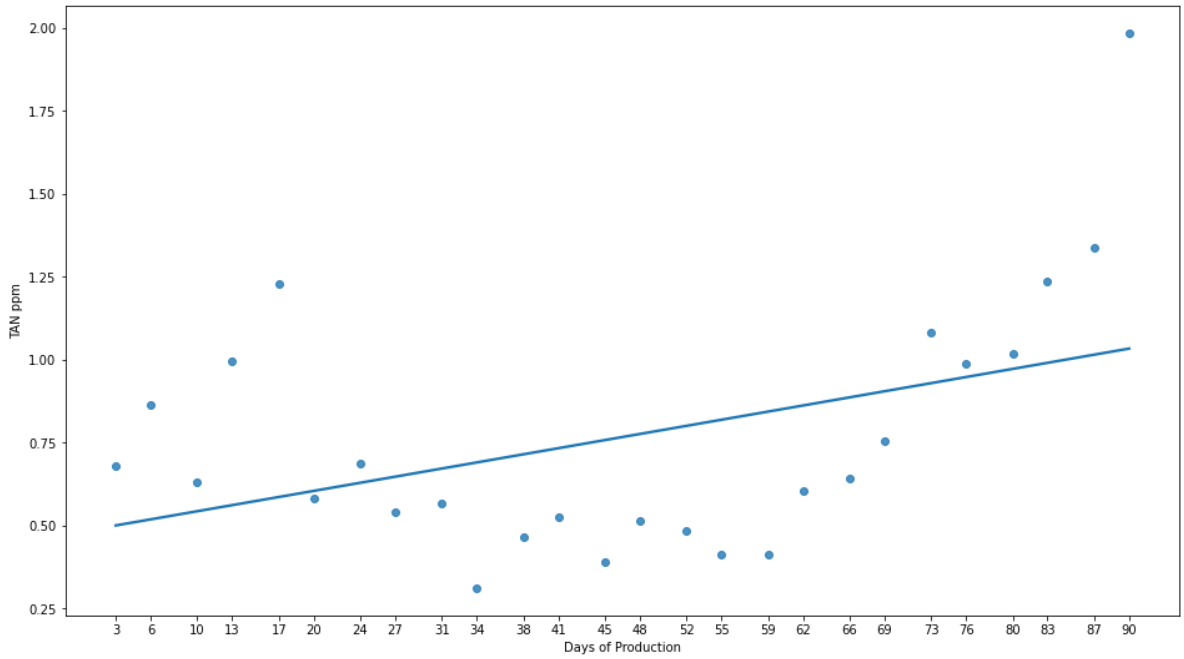
In [34]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = dayvstan)
ax.set(xticks = dayvstan.index)
ax.set_ylabel("TAN ppm")
plt.show()
```



In [35]:

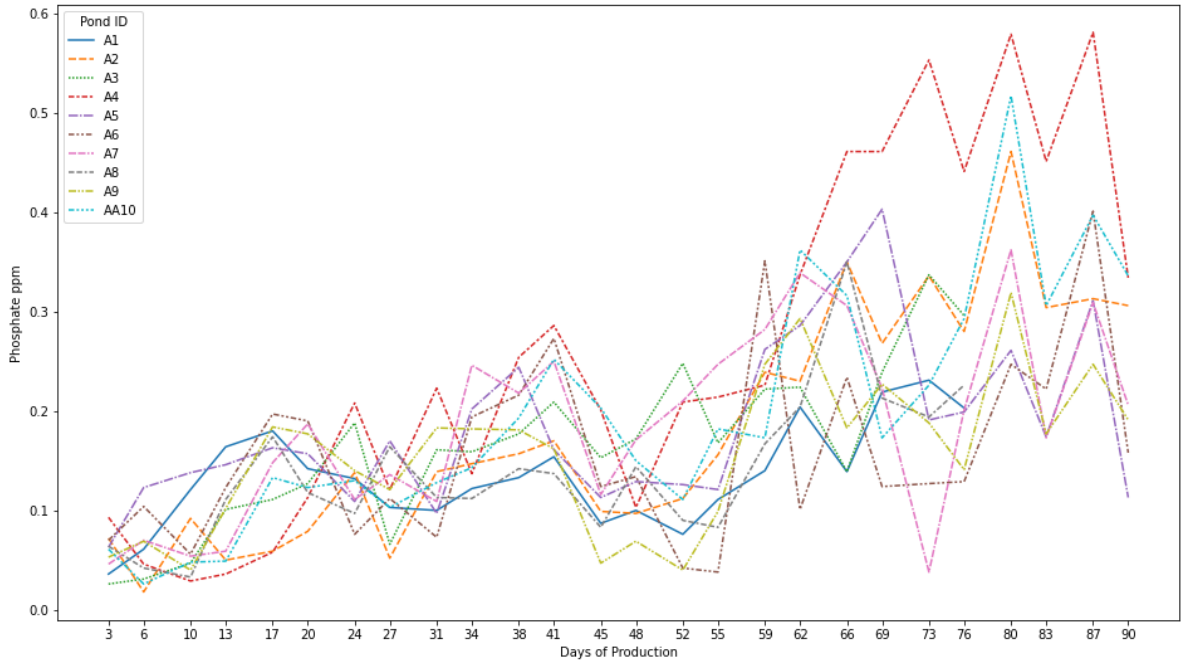
```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Days of Production', as_index=False).mean(), x='D
ax.set(xticks = checknotnull.groupby(by='Days of Production').mean().index)
plt.show()
```



vs Phosphate ppm

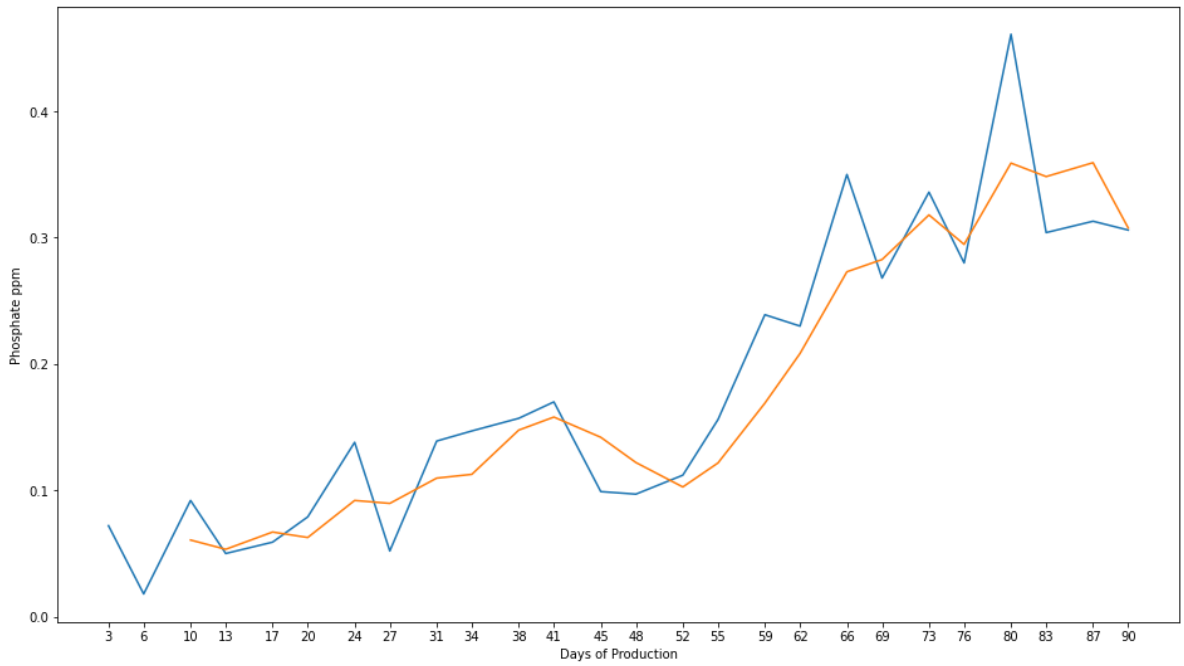
In [36]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = dayvsphos)
ax.set(xticks = dayvsphos.index)
ax.set_ylabel("Phosphate ppm")
plt.show()
```



In [37]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.lineplot(data = dayvsphos['A2'])
sns.lineplot(x=dayvsphos.index, y=dayvsphos['A2'].rolling(3).mean())
ax.set(xticks = dayvsphos.index)
ax.set_ylabel("Phosphate ppm")
plt.show()
```

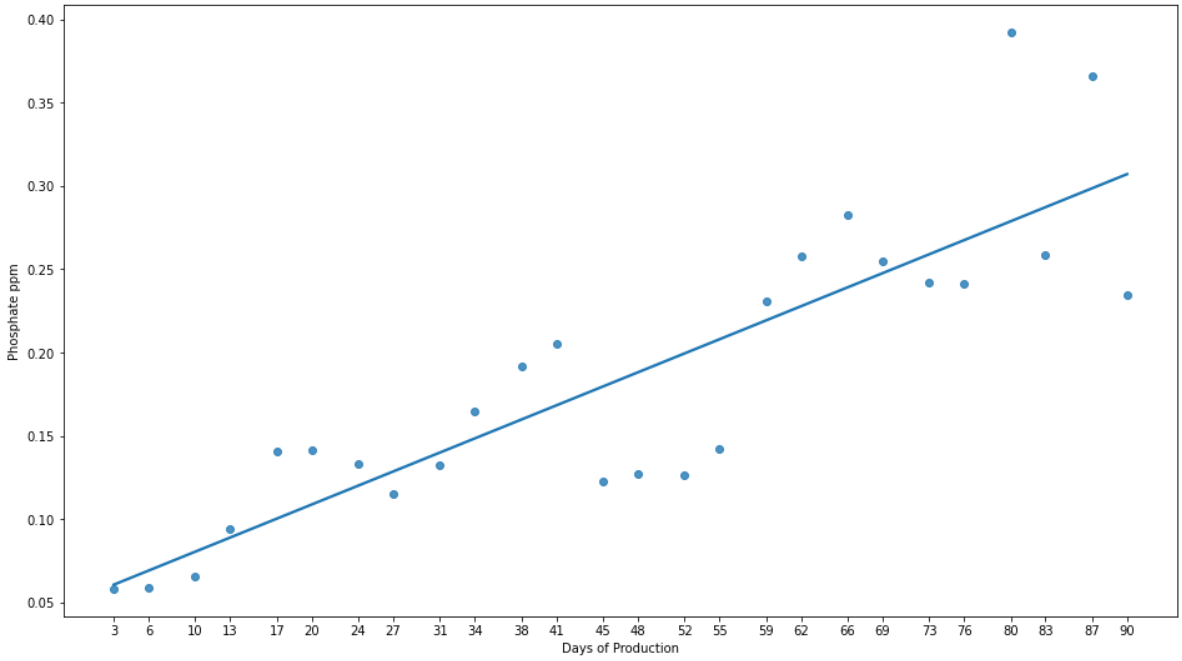


All ponds seems to follow the general pattern that repeating ups and downs, but overall generally increases

over time. Same as before, seems there are specific factor to each ponds causing these ups and downs.

In [38]:

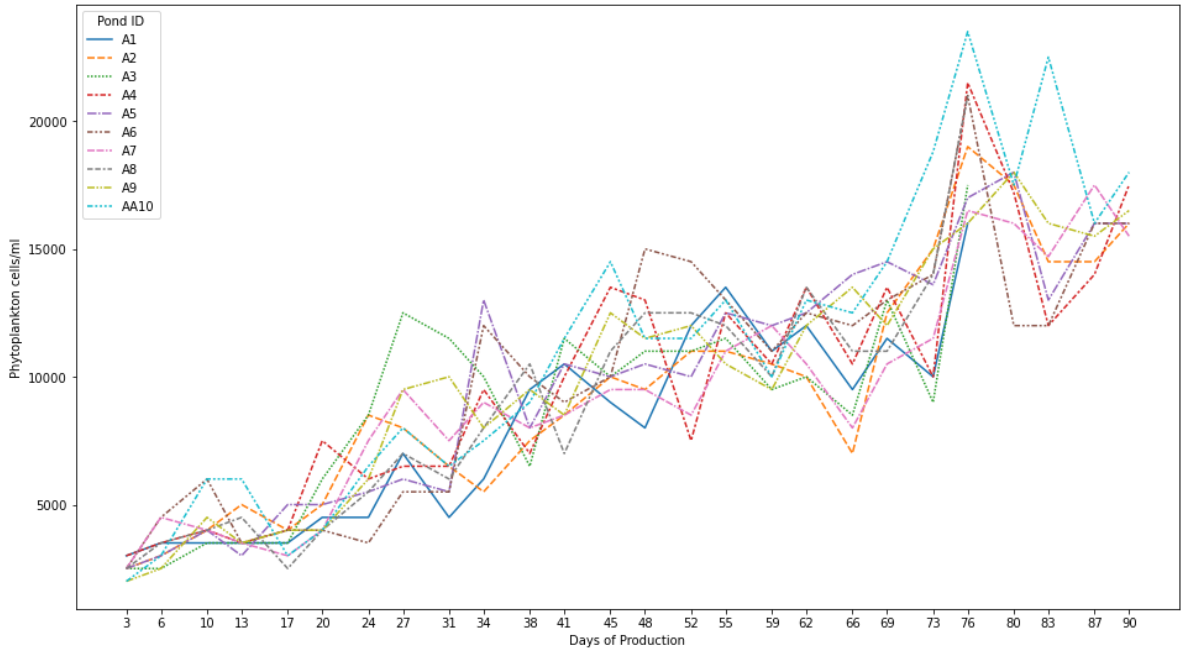
```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Days of Production', as_index=False).mean(), x='D
ax.set(xticks = checknotnull.groupby(by='Days of Production').mean().index)
plt.show()
```



vs Phytoplankton cells/ml

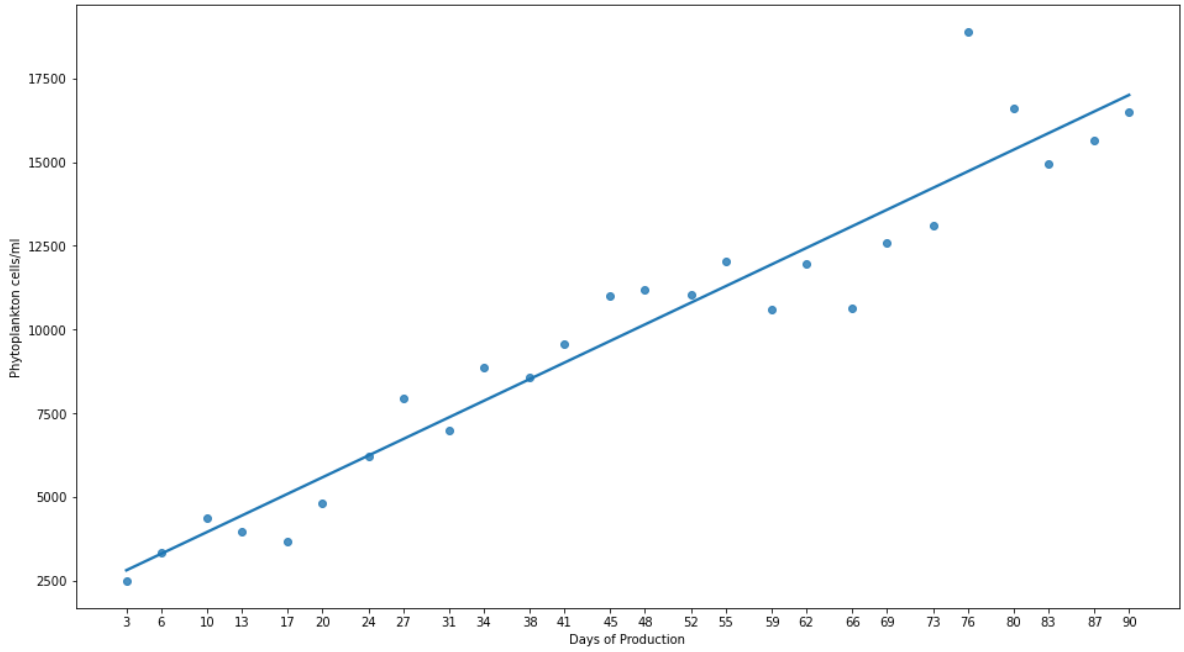
In [39]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = dayvscell)
ax.set(xticks = dayvscell.index)
ax.set_ylabel("Phytoplankton cells/ml")
plt.show()
```



In [40]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Days of Production', as_index=False).mean(), x='D
ax.set(xticks = checknotnull.groupby(by='Days of Production').mean().index)
plt.show()
```



Same cases as Phosphate ppm but much more consistent.

Days of Production influences :

1. Amount of feed given
2. Phospate ppm
3. Pythoplankton density

Daily Temperature Average

Plot below are the average amount of measurement per Average temperature on each Pond ID

In [41]:

```
gbtempid = checknotnull.groupby(by=['Pond ID', 'Temp Avg'], as_index=False).mean()
```

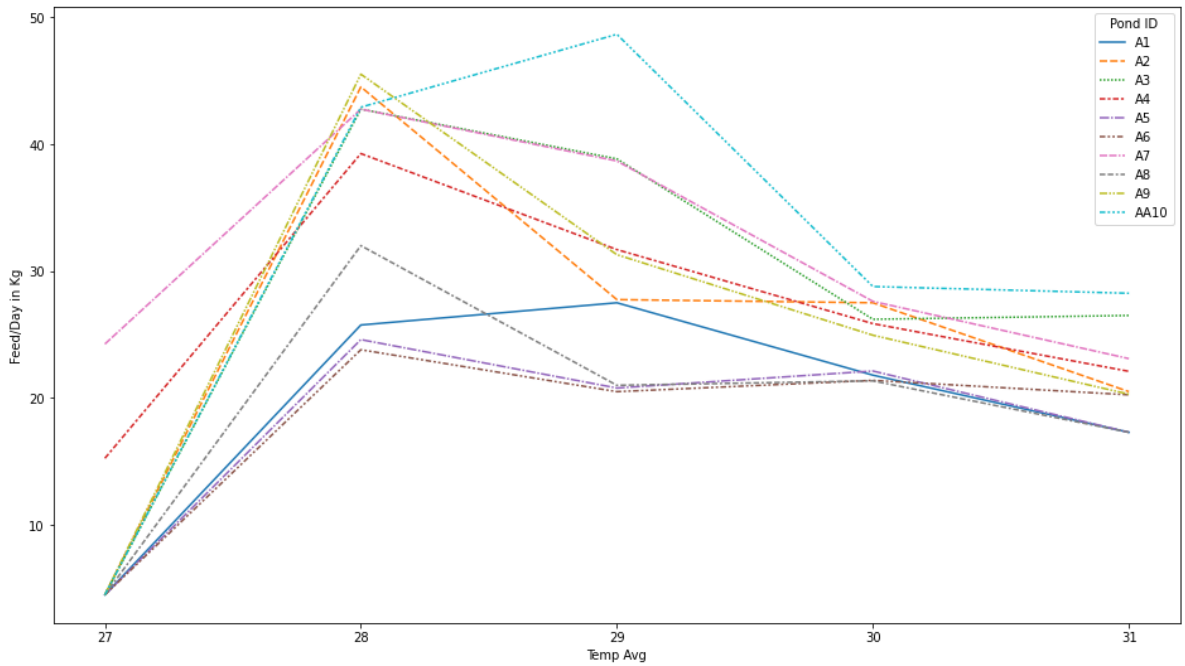
In [42]:

```
tempvsfeed = gbtempid.pivot('Temp Avg', 'Pond ID', 'Feed/Day in Kg')
tempvstan = gbtempid.pivot('Temp Avg', 'Pond ID', 'TAN ppm')
tempvsphos = gbtempid.pivot('Temp Avg', 'Pond ID', 'Phosphate ppm')
tempvscell = gbtempid.pivot('Temp Avg', 'Pond ID', 'Phytoplankton cells/ml')
```

vs Feed/Day in Kg

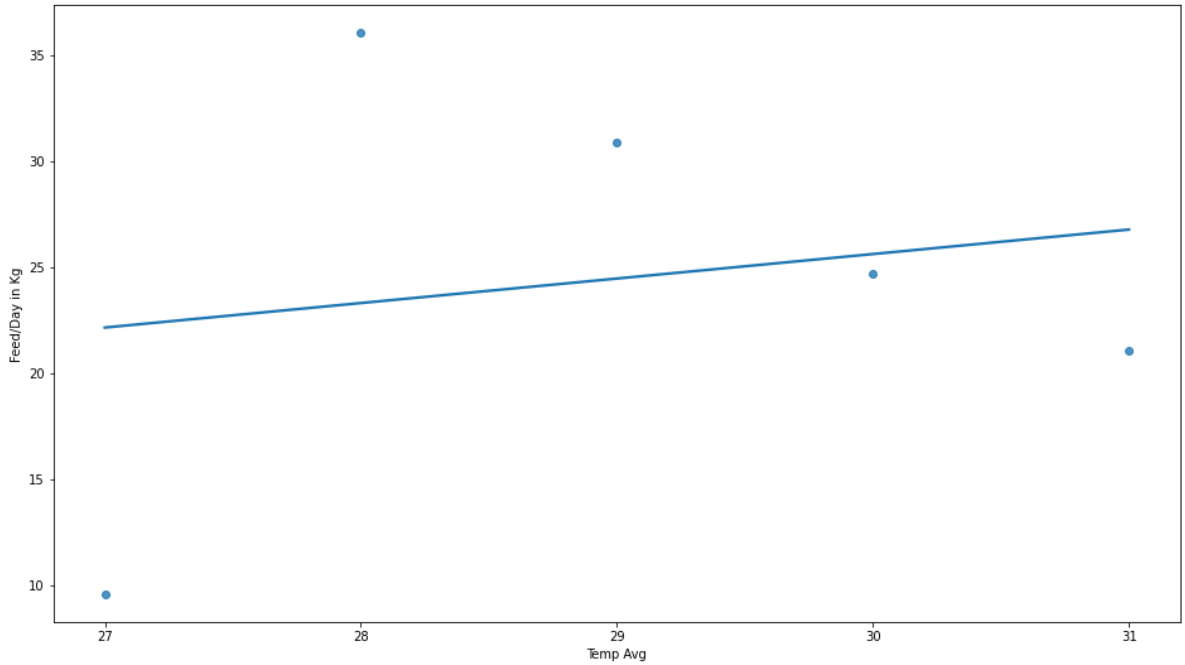
In [43]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = tempvsfeed)
ax.set(xticks = tempvsfeed.index)
ax.set_ylabel("Feed/Day in Kg")
plt.show()
```



In [44]:

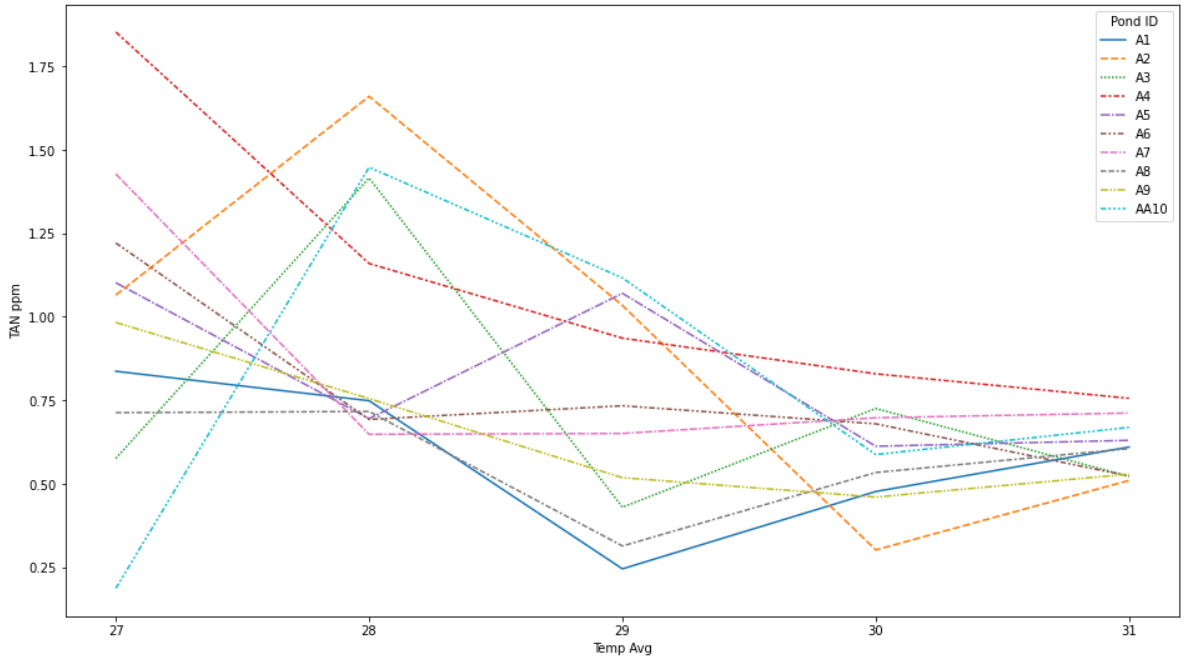
```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Temp Avg', as_index=False).mean(), x='Temp Avg',
ax.set(xticks = checknotnull.groupby(by='Temp Avg').mean().index)
plt.show()
```



vs TAN ppm

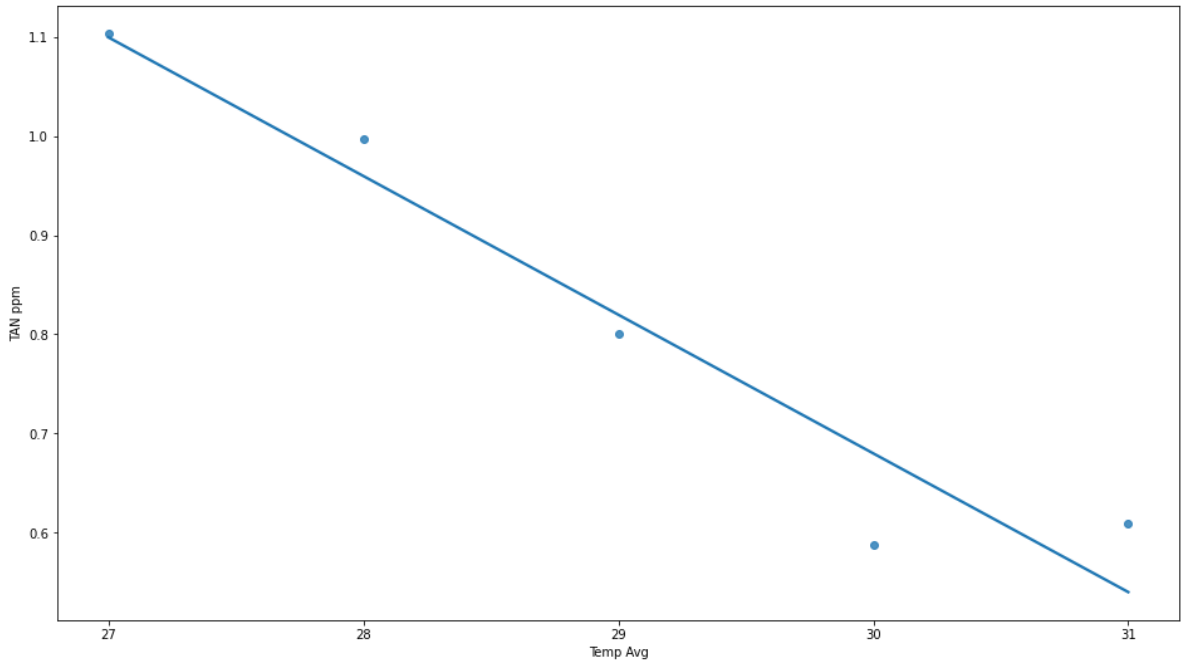
In [45]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = tempvstan)
ax.set(xticks = tempvstan.index)
ax.set_ylabel("TAN ppm")
plt.show()
```



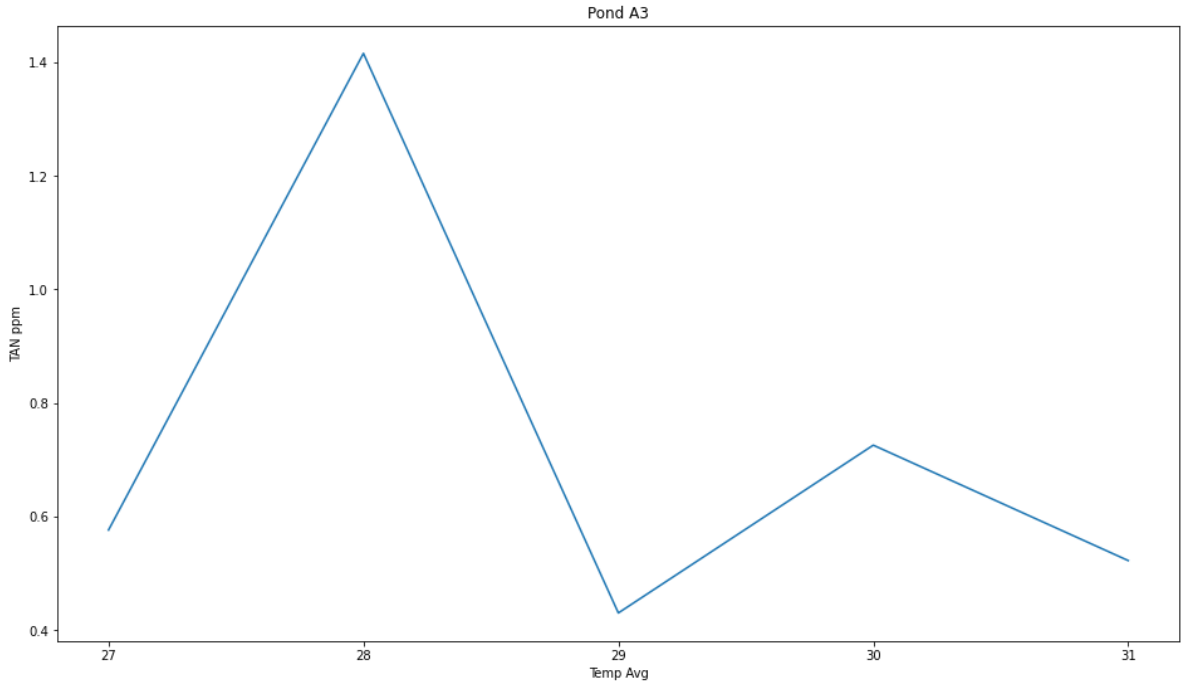
In [46]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Temp Avg', as_index=False).mean(), x='Temp Avg',
ax.set(xticks = checknotnull.groupby(by='Temp Avg').mean().index)
plt.show()
```



In [47]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.lineplot(data = tempvstan['A3']).set_title('Pond A3')
ax.set(xticks = tempvstan.index)
ax.set_ylabel("TAN ppm")
plt.show()
```

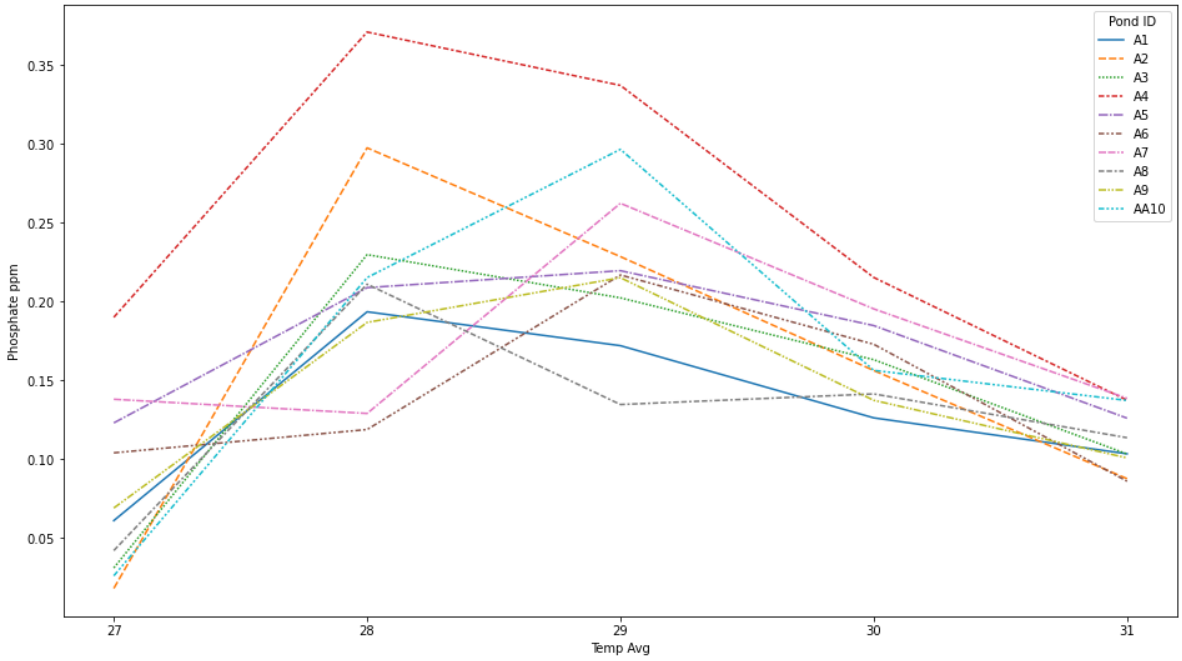


While on average we can see that the the amount of TAN ppm decreases as the temperature increases, looking at the Pond individually, some ponds does not behave closely to other ponds or the average behavior.

vs Phosphate ppm

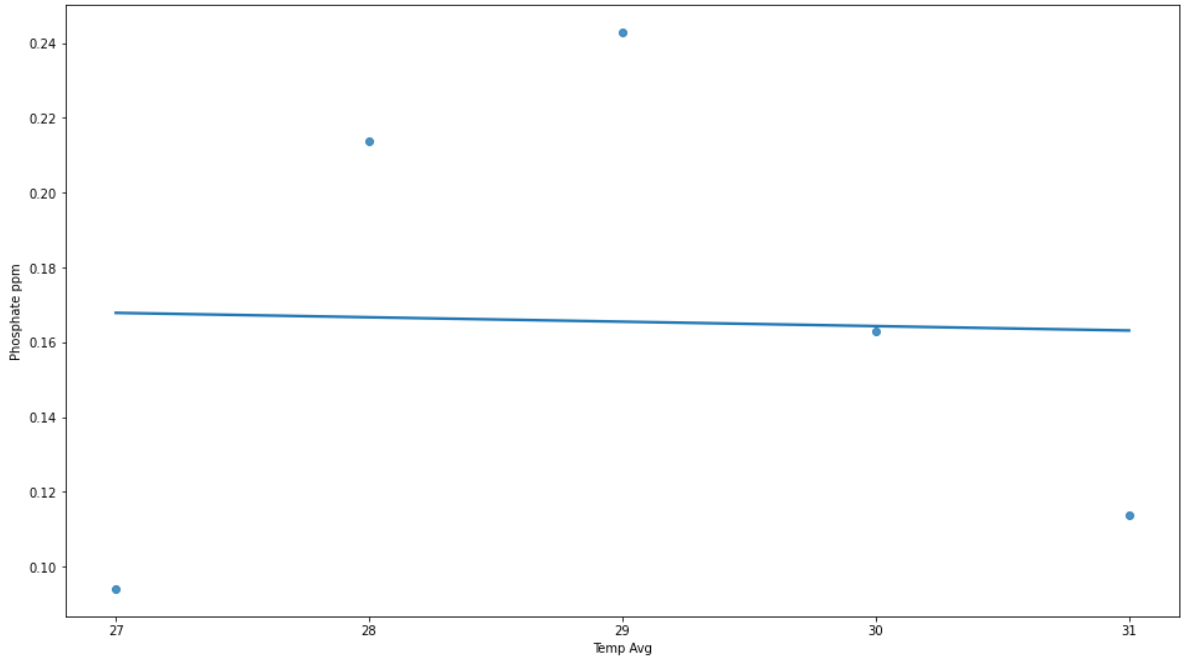
In [48]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = tempvsphos)
ax.set(xticks = tempvsphos.index)
ax.set_ylabel("Phosphate ppm")
plt.show()
```



In [49]:

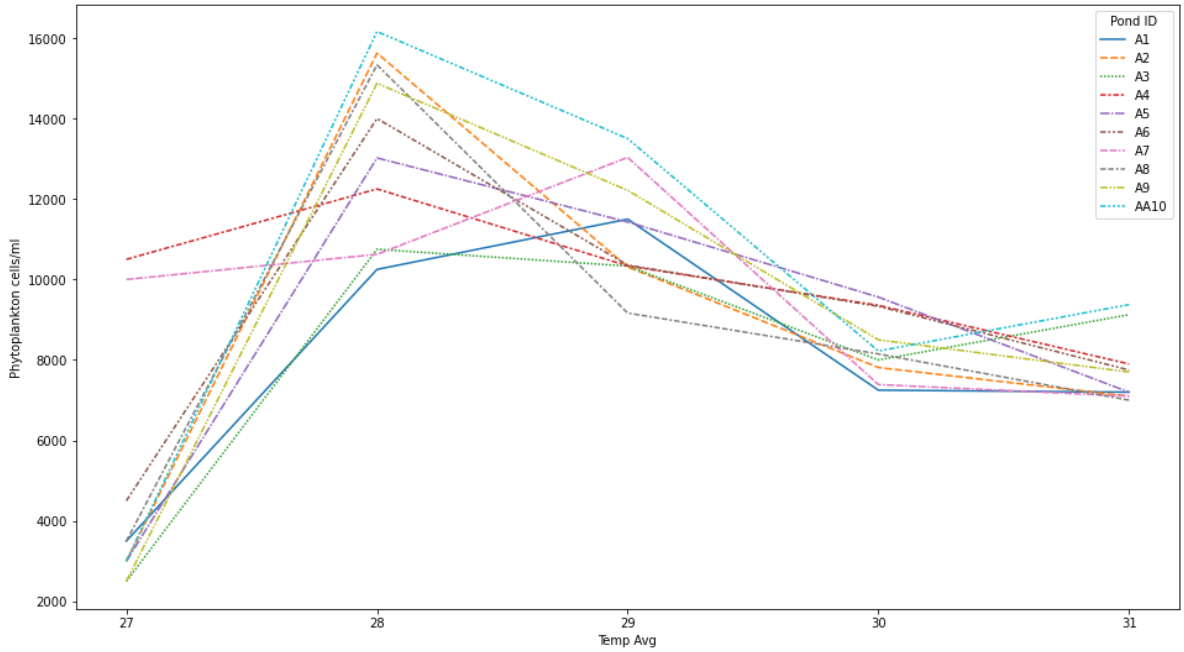
```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Temp Avg', as_index=False).mean(), x='Temp Avg',
ax.set(xticks = checknotnull.groupby(by='Temp Avg').mean().index)
plt.show()
```



vs Phytoplankton cells/ml

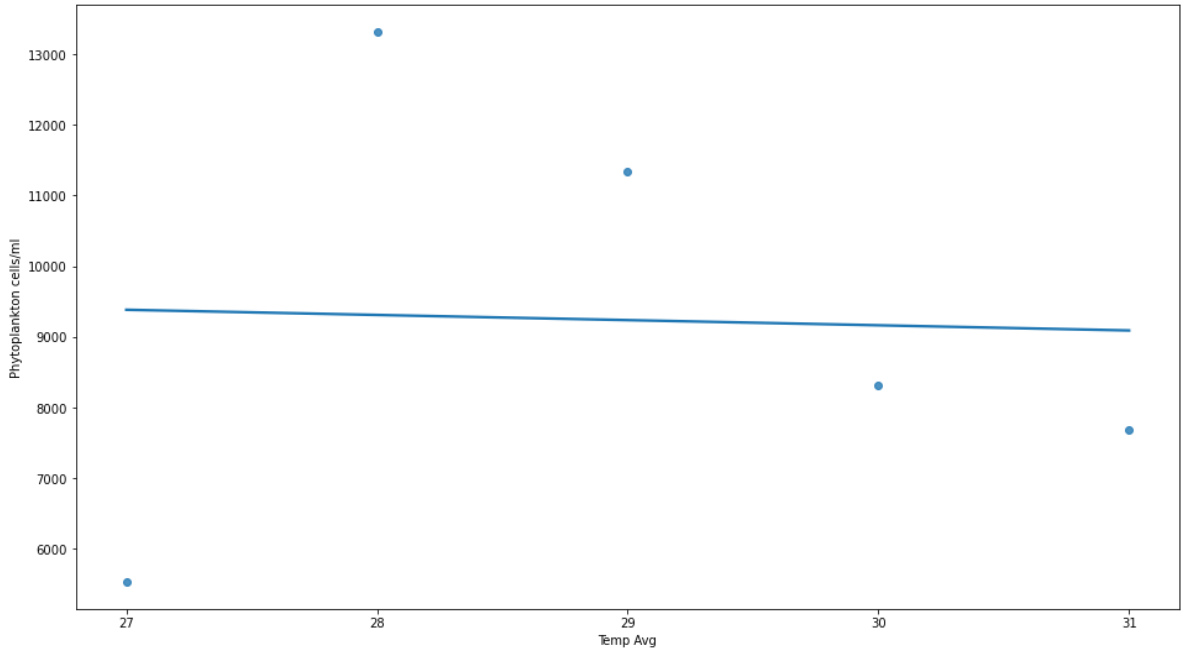
In [50]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = tempvscell)
ax.set(xticks = tempvscell.index)
ax.set_ylabel("Phytoplankton cells/ml")
plt.show()
```



In [51]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Temp Avg', as_index=False).mean(), x='Temp Avg',
ax.set(xticks = checknotnull.groupby(by='Temp Avg').mean().index)
plt.show()
```



Daily Temperature Average influences :

1. TAN (Total Ammonia Nitrate) ppm.

with that being said, based on the individual pond plot, there are few ponds that doesnt follow the pattern. I assume there are properties/condition/treatment that are unique to each pond that also affect this measurement.

Feed per Day

Plot below are the average amount of measurement on average Feed/Day per each Pond ID

In [52]:

```
gbfeedid = checknotnull.groupby(by=['Pond ID', 'Feed/Day in Kg'], as_index=False).mean()
```

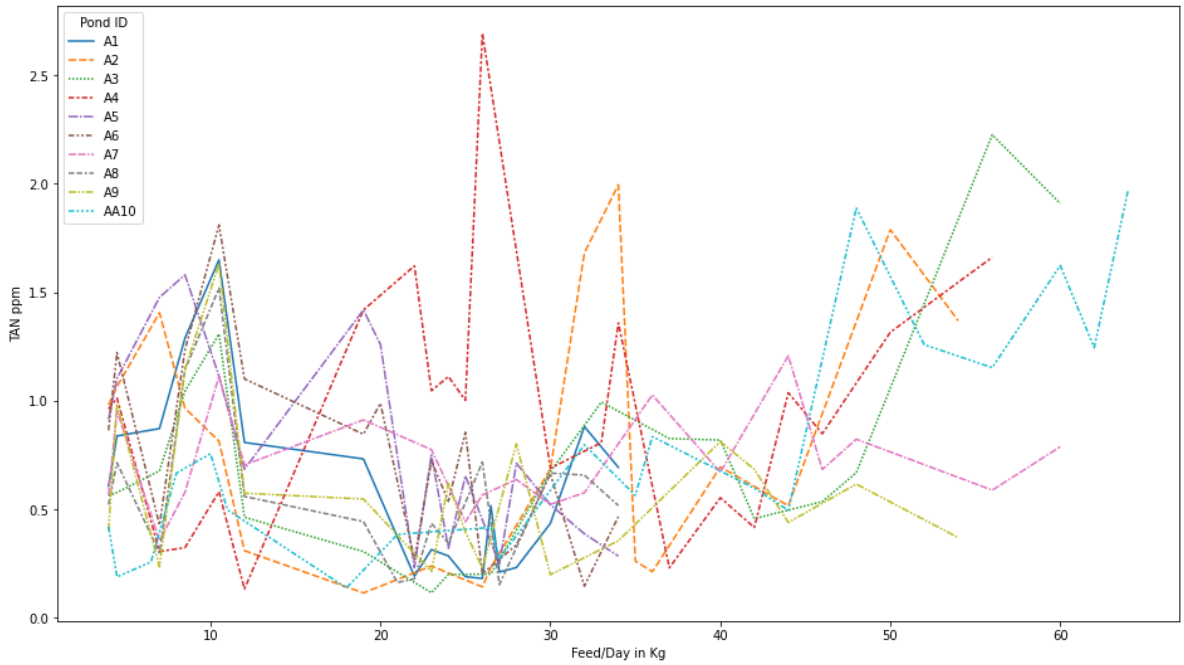
In [53]:

```
feedvstan = gbfeedid.pivot('Feed/Day in Kg', 'Pond ID', 'TAN ppm')
feedvsphos = gbfeedid.pivot('Feed/Day in Kg', 'Pond ID', 'Phosphate ppm')
feedvscell = gbfeedid.pivot('Feed/Day in Kg', 'Pond ID', 'Phytoplankton cells/ml')
```

vs TAN ppm

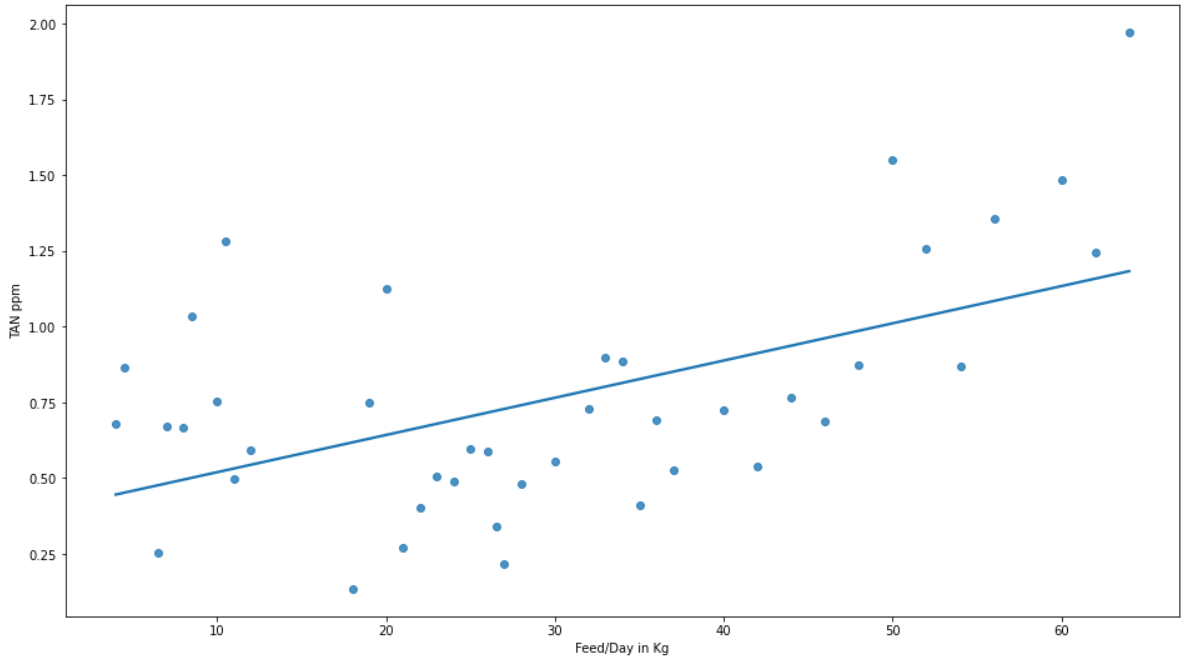
In [54]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = feedvstan)
ax.set_ylabel("TAN ppm")
plt.show()
```



In [55]:

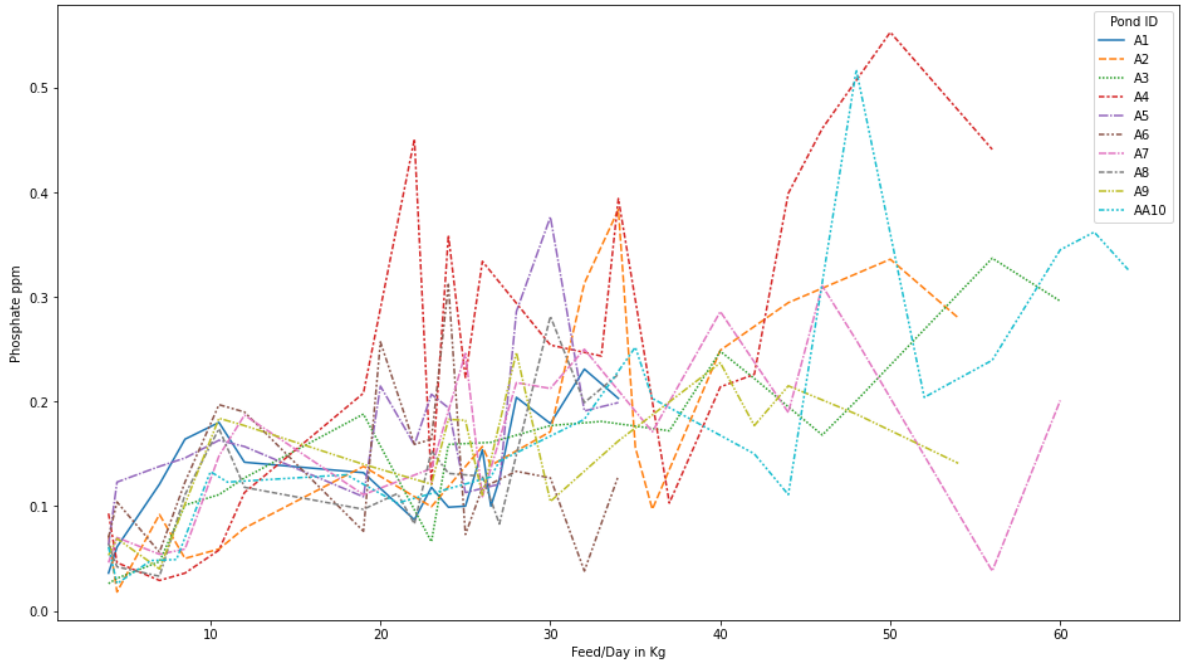
```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Feed/Day in Kg', as_index=False).mean(), x='Feed/
plt.show()
```



vs Phosphate ppm

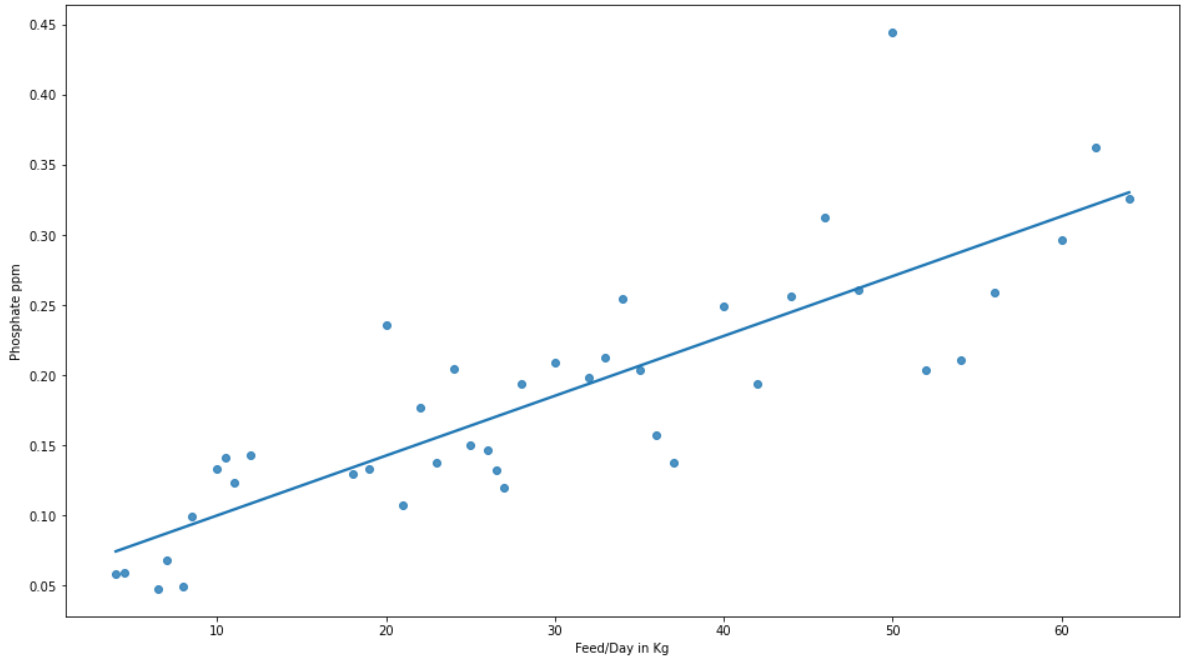
In [56]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = feedvsphos)
ax.set_ylabel("Phosphate ppm")
plt.show()
```



In [57]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Feed/Day in Kg', as_index=False).mean(), x='Feed/
plt.show()
```

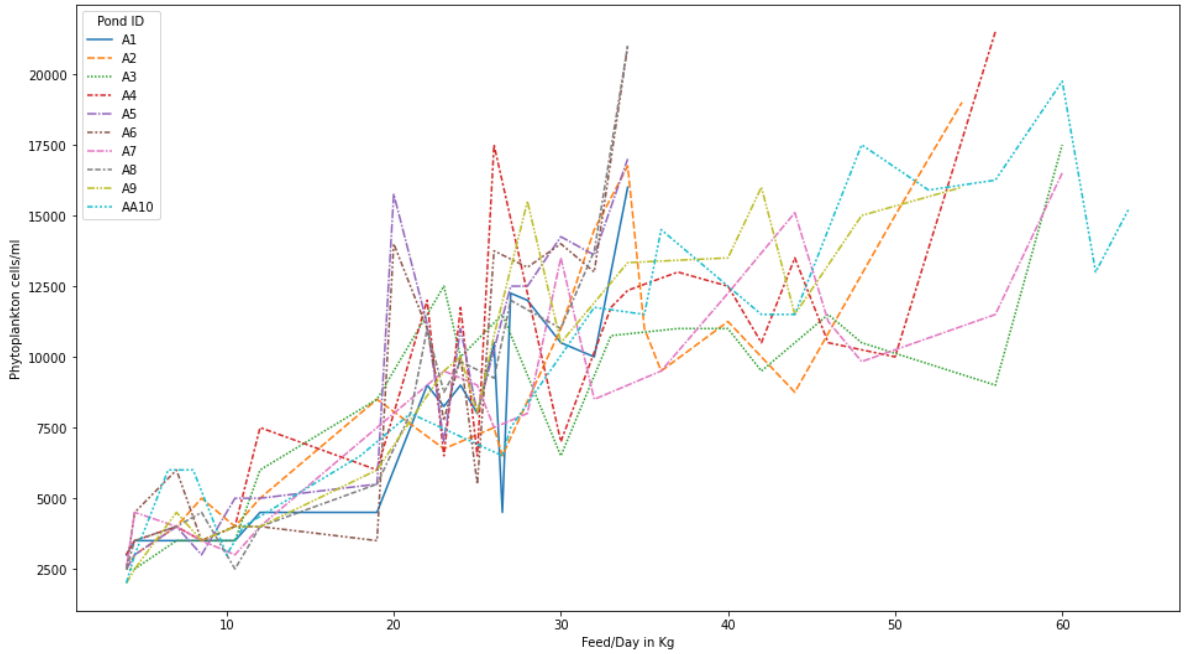


aside from few outliers, generally, amount of phosphate ppm generally increases as feed amount increases.

vs Phytoplankton cells/ml

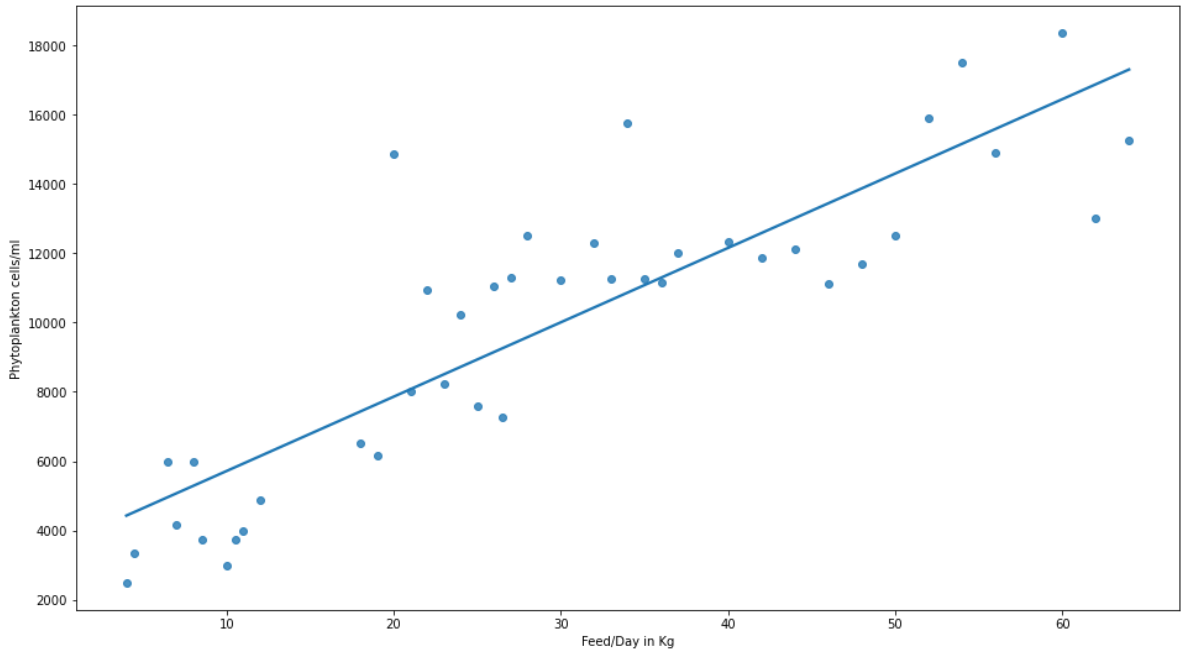
In [58]:

```
fig, ax = plt.subplots(figsize=(16, 9))
ax = sns.lineplot(data = feedvscell)
ax.set_ylabel("Phytoplankton cells/ml")
plt.show()
```



In [59]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=checknotnull.groupby(by='Feed/Day in Kg', as_index=False).mean(), x='Feed/
plt.show()
```



Same case with Phosphate ppm, but if we refer back to 'Days of Production', 'Days of Production' also affects amount of feed and amount of Phytoplankton cells/ml, so because over the production days both amount of feed and amount of Phytoplankton cells, we cannot be sure that Feed amount causes amount of phytoplankton density.

Amount of Feed per Day influences :

1. Phosphate ppm
2. Phytoplankton cells/ml

Recap : Input

Days of Production influences :

1. 'Feed/Day in KG'
2. 'Phosphate ppm'
3. 'Phytoplankton cells/ml'

Daily Average Temperature influences :

1. 'TAN ppm'

Amount of Feed per day influences :

1. 'Phosphate ppm'
2. 'Phytoplankton cells/ml'

Regarding 'Phospate ppm' and 'Phytoplankton cells/ml', because Feed/Day increases as the production days goes, we cant be sure if the increase in Phosphate ppm and Phytoplankton cells/ml is caused due to either the production days or the feed amount or both.

Daily Average Across All Ponds

Below value are day average across all ponds, to see if on average if each parameters related to each other or not.

In [60]:

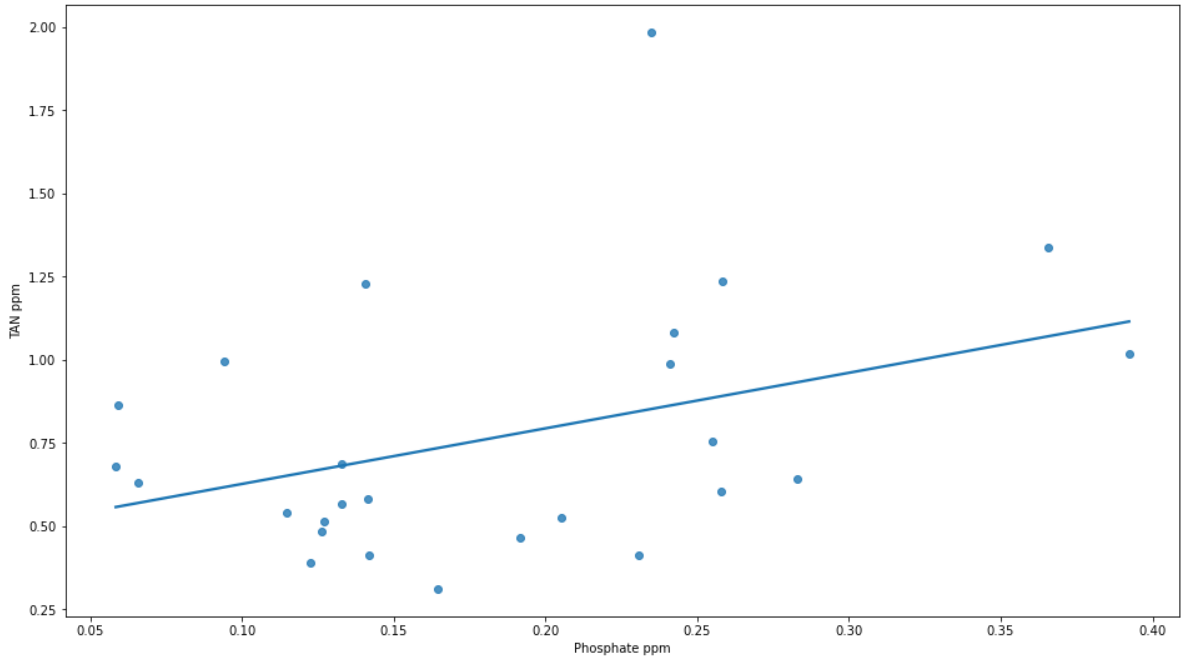
```
days = checknotnull.groupby(by=['Days of Production'], as_index=False).mean()
days
```

Out[60]:

	Days of Production	Temp Avg	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	P
0	3	31.000000	29.300000	32.1	31.000000	4.000000	0.678700	0.058400	
1	6	27.000000	27.000000	27.0	27.000000	4.500000	0.864900	0.059000	
2	10	28.300000	28.000000	29.0	28.300000	6.950000	0.629900	0.065800	
3	13	29.600000	29.000000	30.5	29.100000	8.450000	0.996400	0.094100	
4	17	30.700000	29.400000	32.0	30.700000	10.450000	1.228800	0.140700	
5	20	30.000000	29.000000	31.0	30.000000	11.900000	0.582200	0.141300	
6	24	30.000000	30.000000	30.0	30.000000	18.900000	0.686400	0.132900	
7	27	31.000000	30.300000	32.0	30.800000	22.800000	0.540900	0.114800	
8	31	29.200000	28.700000	29.8	29.200000	25.700000	0.566100	0.132600	
9	34	30.000000	29.000000	31.4	29.800000	23.700000	0.312400	0.164400	
10	38	29.800000	29.000000	30.2	29.800000	26.400000	0.463200	0.191500	
11	41	30.000000	29.000000	31.6	30.000000	28.900000	0.523700	0.205400	
12	45	31.000000	29.300000	32.0	31.000000	28.000000	0.389500	0.122600	
13	48	30.000000	30.000000	31.0	30.000000	32.400000	0.512200	0.126900	
14	52	30.000000	29.000000	31.0	30.200000	31.400000	0.484800	0.126400	
15	55	31.000000	29.800000	31.6	31.000000	36.800000	0.411700	0.141900	
16	59	29.000000	29.000000	30.0	29.000000	37.300000	0.410500	0.230900	
17	62	29.000000	28.000000	30.0	29.000000	39.400000	0.603300	0.258000	
18	66	29.900000	28.800000	30.5	30.000000	41.200000	0.642800	0.282800	
19	69	28.000000	27.000000	29.0	29.000000	37.000000	0.752600	0.255000	
20	73	28.000000	27.000000	29.0	29.000000	43.800000	1.081800	0.242100	
21	76	28.000000	28.000000	29.0	28.000000	48.000000	0.987400	0.240900	
22	80	29.000000	28.714286	30.0	29.000000	32.857143	1.016571	0.392286	
23	83	29.142857	28.428571	30.0	29.142857	33.428571	1.237286	0.258143	
24	87	29.000000	28.857143	30.0	29.000000	30.571429	1.335857	0.365571	
25	90	27.714286	27.142857	28.0	27.714286	35.428571	1.984286	0.234857	

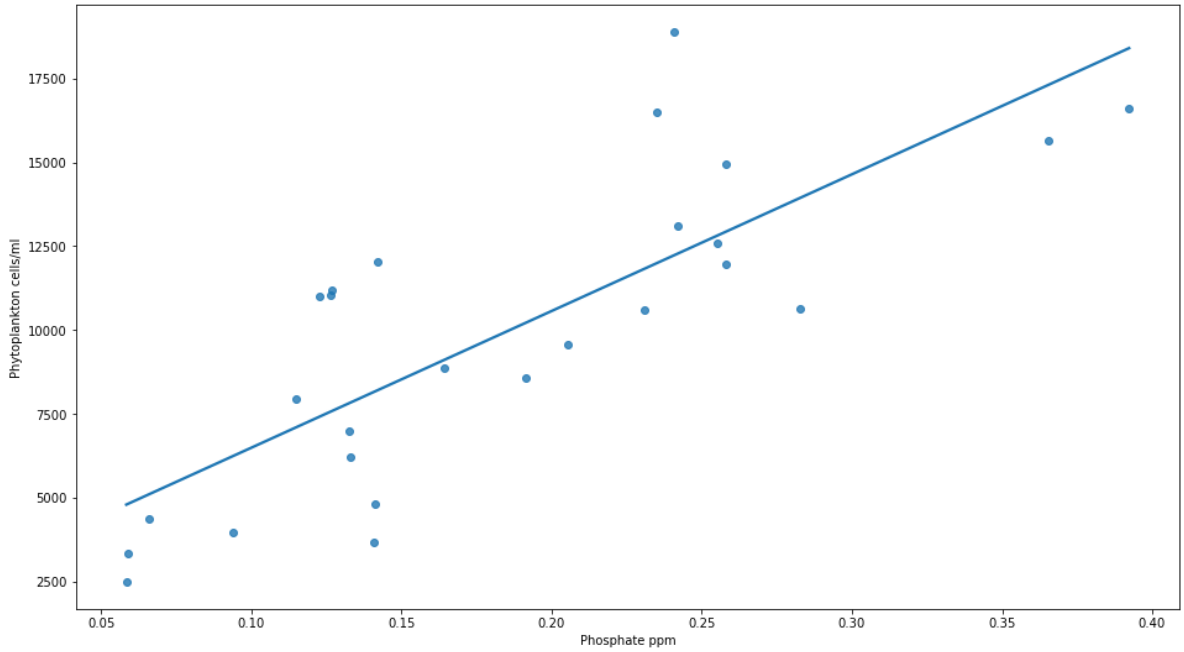
In [61]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=days, x='Phosphate ppm', y='TAN ppm', ci=None)
plt.show()
```



In [62]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=days, x='Phosphate ppm', y='Phytoplankton cells/ml', ci=None)
plt.show()
```

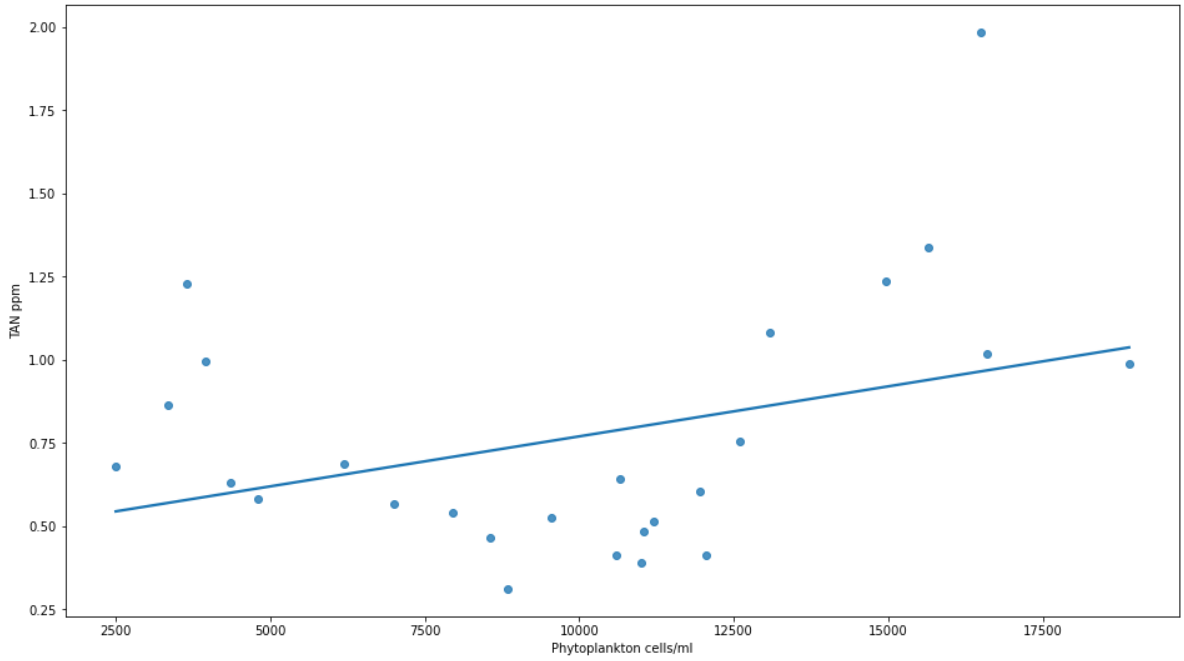


Even though the plot show that 'Phytoplankton cells/ml' increases as 'Phosphate ppm' increases, refering back to previous recap, both 'Phytoplankton cells/ml' and 'Phosphate ppm' are affected by 'Feed/Day in Kg' which generally increases over the production days.

unless there some test conducted that directly changes "Pythoplankton cells/ml" or "Phosphate ppm" without changing the amount of 'Feed/Day in Kg' i wouldnt say these two parameters are dependent on each other.

In [63]:

```
fig, ax = plt.subplots(figsize=(16, 9))
sns.regplot(data=days, x='Phytoplankton cells/ml', y='TAN ppm', ci=None)
plt.show()
```



Conclusion

After analyzing each parameters over input presented in this dataset, i conclude that :

1. On average, Feed/Day in KG increases over production days goes but not related to temperature
2. On average, Temperature does related to amount of 'TAN ppm', as the Temperature rises, 'TAN ppm' decreases
3. On average, 'Phosphate ppm' and 'Phytoplankton cells/ml' affected by either or both 'Days of Production' or 'Feed/Day in Kg'

Keep in mind that these are on average over all ponds, when compared to individual pond, there are few ponds that does not follow the average, with that, i infere that there are some data point related to each pond that also affect the parameters.

==========

==========

In [64]:

```
df4
```

Out[64]:

	Days of Production	Pond ID	Temp Avg	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phyt
0	1	A1	29.0	29	30	29	3.5	NaN	NaN	
1	2	A1	30.0	30	32	29	3.5	NaN	NaN	
2	3	A1	31.0	29	33	31	4.0	0.606	0.036	
3	4	A1	31.0	29	32	31	4.0	NaN	NaN	
4	5	A1	29.0	30	30	28	4.5	NaN	NaN	
...	...	...	...	...	...	...	...	...	...	
884	90	AA10	28.0	28	28	28	64.0	2.633	0.336	
885	91	AA10	28.0	27	29	29	64.0	NaN	NaN	
886	92	AA10	29.0	28	29	29	64.0	NaN	NaN	
887	93	AA10	28.0	28	28	28	64.0	NaN	NaN	
888	94	AA10	28.0	27	28	28	64.0	NaN	NaN	

889 rows × 10 columns

In [65]:

```
checknotnull
```

Out[65]:

	Days of Production	Pond ID	Temp Avg	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phyt
2	3	A1	31.0	29	33	31	4.0	0.606	0.036	
5	6	A1	27.0	27	27	27	4.5	0.837	0.061	
9	10	A1	28.0	28	29	28	7.0	0.871	0.121	
12	13	A1	30.0	29	31	29	8.5	1.288	0.164	
16	17	A1	31.0	29	32	31	10.5	1.649	0.180	
...	...	...	...	...	...	...	...	...	...	
870	76	AA10	28.0	28	29	28	60.0	1.825	0.293	
874	80	AA10	29.0	29	30	29	48.0	1.888	0.517	
877	83	AA10	29.0	28	30	29	56.0	1.320	0.306	
881	87	AA10	29.0	28	30	29	60.0	1.421	0.397	
884	90	AA10	28.0	28	28	28	64.0	2.633	0.336	

248 rows × 10 columns

In [66]:

```
checknotnull['Measurement Order'] = checknotnull.groupby(['Pond ID']).cumcount()+1
```

```
C:\Users\fadhl\AppData\Local\Temp/ipykernel_8348/3977013409.py:1: SettingWit
hCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy (https://pand
as.pydata.org/pandas-docs/stable/user_guide/indexing.html#returning-a-view-v
ersus-a-copy)
  checknotnull['Measurement Order'] = checknotnull.groupby(['Pond ID']).cumc
ount()+1
```

In [67]:

```
checknotnull.head(23)
```

Out[67]:

	Days of Production	Pond ID	Temp Avg	Morning Temp	Afternoon Temp	Evening Temp	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytc
2	3	A1	31.0	29	33	31	4.0	0.606	0.036	
5	6	A1	27.0	27	27	27	4.5	0.837	0.061	
9	10	A1	28.0	28	29	28	7.0	0.871	0.121	
12	13	A1	30.0	29	31	29	8.5	1.288	0.164	
16	17	A1	31.0	29	32	31	10.5	1.649	0.180	
19	20	A1	30.0	29	31	30	12.0	0.807	0.142	
23	24	A1	30.0	30	30	30	19.0	0.731	0.132	
26	27	A1	31.0	30	32	31	23.0	0.448	0.103	
30	31	A1	30.0	29	30	30	26.5	0.516	0.100	
33	34	A1	30.0	29	32	30	24.0	0.305	0.122	
37	38	A1	30.0	29	30	30	23.0	0.178	0.133	
40	41	A1	30.0	29	32	30	26.0	0.180	0.154	
44	45	A1	31.0	29	32	31	22.0	0.190	0.087	
47	48	A1	30.0	30	31	30	25.0	0.188	0.100	
51	52	A1	30.0	29	31	30	24.0	0.262	0.076	
54	55	A1	31.0	30	32	31	27.0	0.158	0.111	
58	59	A1	29.0	29	30	29	27.0	0.261	0.140	
61	62	A1	29.0	28	30	29	28.0	0.230	0.204	
65	66	A1	30.0	29	31	30	30.0	0.315	0.139	
68	69	A1	28.0	27	29	29	30.0	0.552	0.219	
72	73	A1	28.0	27	29	29	32.0	0.880	0.231	
75	76	A1	28.0	28	29	28	34.0	0.692	0.203	
79	3	A2	31.0	29	32	31	4.0	0.979	0.072	

In [68]:

```
df2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 889 entries, 0 to 888
Data columns (total 10 columns):
 #   Column                  Non-Null Count  Dtype  
---  ------                  --------------  -----  
 0   Days of Production      889 non-null    int64  
 1   Pond ID                 889 non-null    object 
 2   Morning Temp            889 non-null    int64  
 3   Afternoon Temp          889 non-null    int64  
 4   Evening Temp            889 non-null    int64  
 5   Feed/Day in Kg          804 non-null    float64
 6   TAN ppm                 248 non-null    float64
 7   Phosphate ppm           248 non-null    float64
 8   Phytoplankton cells/ml  248 non-null    float64
 9   Temp Avg                889 non-null    float64
dtypes: float64(5), int64(4), object(1)
memory usage: 69.6+ KB
```

In [69]:

```
model2=pd.merge(df4[['Pond ID', 'Morning Temp', 'Afternoon Temp', 'Evening Temp', 'Temp Avg
                     'TAN ppm', 'Phosphate ppm', 'Phytoplankton cells/ml']],checknotnull['Me
         left_index=True, right_index=True, copy=False, how='left')

model2
```

Out[69]:

	Pond ID	Morning Temp	Afternoon Temp	Evening Temp	Temp Avg	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytoplankton cells/ml	M
0	A1	29	30	29	29.0	3.5	NaN	NaN	NaN	
1	A1	30	32	29	30.0	3.5	NaN	NaN	NaN	
2	A1	29	33	31	31.0	4.0	0.606	0.036	3000.0	
3	A1	29	32	31	31.0	4.0	NaN	NaN	NaN	
4	A1	30	30	28	29.0	4.5	NaN	NaN	NaN	
...	...	...	...	...	...	...	...	...	...	
884	AA10	28	28	28	28.0	64.0	2.633	0.336	18000.0	
885	AA10	27	29	29	28.0	64.0	NaN	NaN	NaN	
886	AA10	28	29	29	29.0	64.0	NaN	NaN	NaN	
887	AA10	28	28	28	28.0	64.0	NaN	NaN	NaN	
888	AA10	27	28	28	28.0	64.0	NaN	NaN	NaN	

889 rows × 10 columns

In [70]:

```
model2['Measurement Order'] = model2.groupby('Pond ID')['Measurement Order'].transform(lamb
model2
```

Out[70]:

	Pond ID	Morning Temp	Afternoon Temp	Evening Temp	Temp Avg	Feed/Day in Kg	TAN ppm	Phosphate ppm	Phytoplankton cells/ml	M
0	A1	29	30	29	29.0	3.5	NaN	NaN	NaN	
1	A1	30	32	29	30.0	3.5	NaN	NaN	NaN	
2	A1	29	33	31	31.0	4.0	0.606	0.036	3000.0	
3	A1	29	32	31	31.0	4.0	NaN	NaN	NaN	
4	A1	30	30	28	29.0	4.5	NaN	NaN	NaN	
...	...	...	...	...	...	...	...	...	...	
884	AA10	28	28	28	28.0	64.0	2.633	0.336	18000.0	
885	AA10	27	29	29	28.0	64.0	NaN	NaN	NaN	
886	AA10	28	29	29	29.0	64.0	NaN	NaN	NaN	
887	AA10	28	28	28	28.0	64.0	NaN	NaN	NaN	
888	AA10	27	28	28	28.0	64.0	NaN	NaN	NaN	

889 rows × 10 columns

In [71]:

```
model2.groupby('Pond ID')['Measurement Order'].max()
```

Out[71]:

```
Pond ID
A1      22.0
A2      26.0
A3      22.0
A4      26.0
A5      26.0
A6      26.0
A7      26.0
A8      22.0
A9      26.0
AA10    26.0
Name: Measurement Order, dtype: float64
```

In [72]:

```
model2 = model2.groupby(['Pond ID', 'Measurement Order'], as_index=False).mean()
model2
```

Out[72]:

	Pond ID	Measurement Order	Morning Temp	Afternoon Temp	Evening Temp	Temp Avg	Feed/Day in Kg	TAN ppm	Phosp
0	A1	1.0	29.333333	31.666667	29.666667	30.000000	3.666667	0.606	0
1	A1	2.0	28.666667	29.666667	28.666667	29.000000	4.333333	0.837	0
2	A1	3.0	27.500000	29.250000	28.750000	28.500000	5.750000	0.871	0
3	A1	4.0	28.333333	30.333333	29.000000	29.333333	8.000000	1.288	0
4	A1	5.0	29.000000	31.250000	30.750000	30.500000	9.750000	1.649	0
...	...	...	...	...	...	...	...	...	
243	AA10	22.0	28.000000	29.666667	28.666667	28.666667	58.666667	1.825	0
244	AA10	23.0	28.000000	30.000000	29.250000	29.000000	35.250000	1.888	0
245	AA10	24.0	28.000000	29.666667	29.000000	29.000000	54.666667	1.320	0
246	AA10	25.0	28.000000	30.250000	29.500000	29.250000	56.250000	1.421	0
247	AA10	26.0	27.666667	28.333333	28.000000	28.000000	61.333333	2.633	0

248 rows × 10 columns

In [73]:

```
cols = ['Morning Temp', 'Afternoon Temp', 'Evening Temp', 'Temp Avg', 'Phytoplankton cells/
model2[cols] = model2[cols].round()
model2['Feed/Day in Kg'] = round((model2['Feed/Day in Kg']*2))/2
model2
```

Out[73]:

	Pond ID	Measurement Order	Morning Temp	Afternoon Temp	Evening Temp	Temp Avg	Feed/Day in Kg	TAN ppm	Phosphate ppm	Pl
0	A1	1.0	29.0	32.0	30.0	30.0	3.5	0.606	0.036	
1	A1	2.0	29.0	30.0	29.0	29.0	4.5	0.837	0.061	
2	A1	3.0	28.0	29.0	29.0	28.0	6.0	0.871	0.121	
3	A1	4.0	28.0	30.0	29.0	29.0	8.0	1.288	0.164	
4	A1	5.0	29.0	31.0	31.0	30.0	10.0	1.649	0.180	
...	...	...	...	...	...	...	...	...	...	
243	AA10	22.0	28.0	30.0	29.0	29.0	58.5	1.825	0.293	
244	AA10	23.0	28.0	30.0	29.0	29.0	35.0	1.888	0.517	
245	AA10	24.0	28.0	30.0	29.0	29.0	54.5	1.320	0.306	
246	AA10	25.0	28.0	30.0	30.0	29.0	56.0	1.421	0.397	
247	AA10	26.0	28.0	28.0	28.0	28.0	61.5	2.633	0.336	

248 rows × 10 columns

In [74]:

```
model2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 248 entries, 0 to 247
Data columns (total 10 columns):
 #   Column                 Non-Null Count  Dtype  
---  ------                 --------------  -----  
 0   Pond ID                248 non-null    object 
 1   Measurement Order      248 non-null    float64
 2   Morning Temp           248 non-null    float64
 3   Afternoon Temp         248 non-null    float64
 4   Evening Temp           248 non-null    float64
 5   Temp Avg               248 non-null    float64
 6   Feed/Day in Kg         248 non-null    float64
 7   TAN ppm                248 non-null    float64
 8   Phosphate ppm          248 non-null    float64
 9   Phytoplankton cells/ml  248 non-null    float64
dtypes: float64(9), object(1)
memory usage: 19.5+ KB
```

In [75]:

```
model2['Measurement Order'] = model2['Measurement Order'].astype('int64')
model2['Morning Temp'] = model2['Morning Temp'].astype('int64')
model2['Afternoon Temp'] = model2['Afternoon Temp'].astype('int64')
model2['Evening Temp'] = model2['Evening Temp'].astype('int64')
model2['Temp Avg'] = model2['Temp Avg'].astype('int64')
model2['Phytoplankton cells/ml'] = model2['Phytoplankton cells/ml'].astype('int64')
model2.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 248 entries, 0 to 247
Data columns (total 10 columns):
 #   Column                 Non-Null Count  Dtype
---  ------                 --------------  -----
 0   Pond ID                248 non-null    object
 1   Measurement Order      248 non-null    int64
 2   Morning Temp           248 non-null    int64
 3   Afternoon Temp         248 non-null    int64
 4   Evening Temp           248 non-null    int64
 5   Temp Avg               248 non-null    int64
 6   Feed/Day in Kg         248 non-null    float64
 7   TAN ppm                248 non-null    float64
 8   Phosphate ppm          248 non-null    float64
 9   Phytoplankton cells/ml  248 non-null    int64
dtypes: float64(3), int64(6), object(1)
memory usage: 19.5+ KB
```

In [76]:

```
model2
```

Out[76]:

	Pond ID	Measurement Order	Morning Temp	Afternoon Temp	Evening Temp	Temp Avg	Feed/Day in Kg	TAN ppm	Phosphate ppm	Pl
0	A1	1	29	32	30	30	3.5	0.606	0.036	
1	A1	2	29	30	29	29	4.5	0.837	0.061	
2	A1	3	28	29	29	28	6.0	0.871	0.121	
3	A1	4	28	30	29	29	8.0	1.288	0.164	
4	A1	5	29	31	31	30	10.0	1.649	0.180	
...	...	...	...	...	...	...	...	...	...	
243	AA10	22	28	30	29	29	58.5	1.825	0.293	
244	AA10	23	28	30	29	29	35.0	1.888	0.517	
245	AA10	24	28	30	29	29	54.5	1.320	0.306	
246	AA10	25	28	30	30	29	56.0	1.421	0.397	
247	AA10	26	28	28	28	28	61.5	2.633	0.336	

248 rows × 10 columns