ST. MARY LAKE DYNAMICS

John B. Sprague, Ph.D.

To Steering Committee, SSIWPA

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Part 1.

The smaller inputs of phosphorus

Yearly inputs of P

from Management Plan .....

- Septic 5 kg
- Groundwater 10 kg
- Waterbirds 13 kg
- Aerial 20 kg
- Land runoff 50 – 150 kg (say 100 kg)

Possible reductions ?????

Potential reduction ....

- Total, these 5 sources — approx. 150 kg
- Possible reduction — down to 100

- Benefit — = 50 kg

.... optimistic

Part 2

Larger source of phosphorus

.... the sediment

Initial P from sediment at autumn turnover

Estimates by spring-to-autumn change .....

- 450 kg/year (Nordin et al. 1983)
- 450 kg/year (Hodgins 2015)
- 563 kg/year (Watson 2013)

JBS estimate

- Compare total P in lake just after autumn turnover
- Compare aerated with non-aerated years. ...

  the difference = initial load from sediment

- Early aerator:
- 3 years without aeration:

		3 years with successful aeration:
(1979) 699 kg	(1988)	540 kg
(1980)1062 kg	(1989)	306 kg
(1981)1054 kg	(1990)	534 kg

Average = 938 kg Average = 460 kg

Difference = 478 kg

JBS estimate

- Recent aerators:
- 4 years without aeration:

(2005)	1273 kg
(2006)	872 kg
(2007)	551 kg
(2008)	621 kg

Average = 829 kg

2 years with successful aeration:

(2009)	434 kg
(2010)	303 kg

Average = 368.5 kg

Difference = 460.5 kg

JBS estimate

- For the two periods of time .....

Average difference for aeration/no aeration

= (478 + 460.5) / 2 = 470 kg

Initial P from sediment at autumn turnover

Now we have four independent estimates (years of no aeration) .....

- 450 kg/year (Nordin et al. 1983)
- 450 kg/year (Hodgins 2015)
- 563 kg/year (Watson 2013)
- 470 kg/year (Sprague 2014)

Let us generalize as 450 to 500 kg per year for initial P from the sediment.

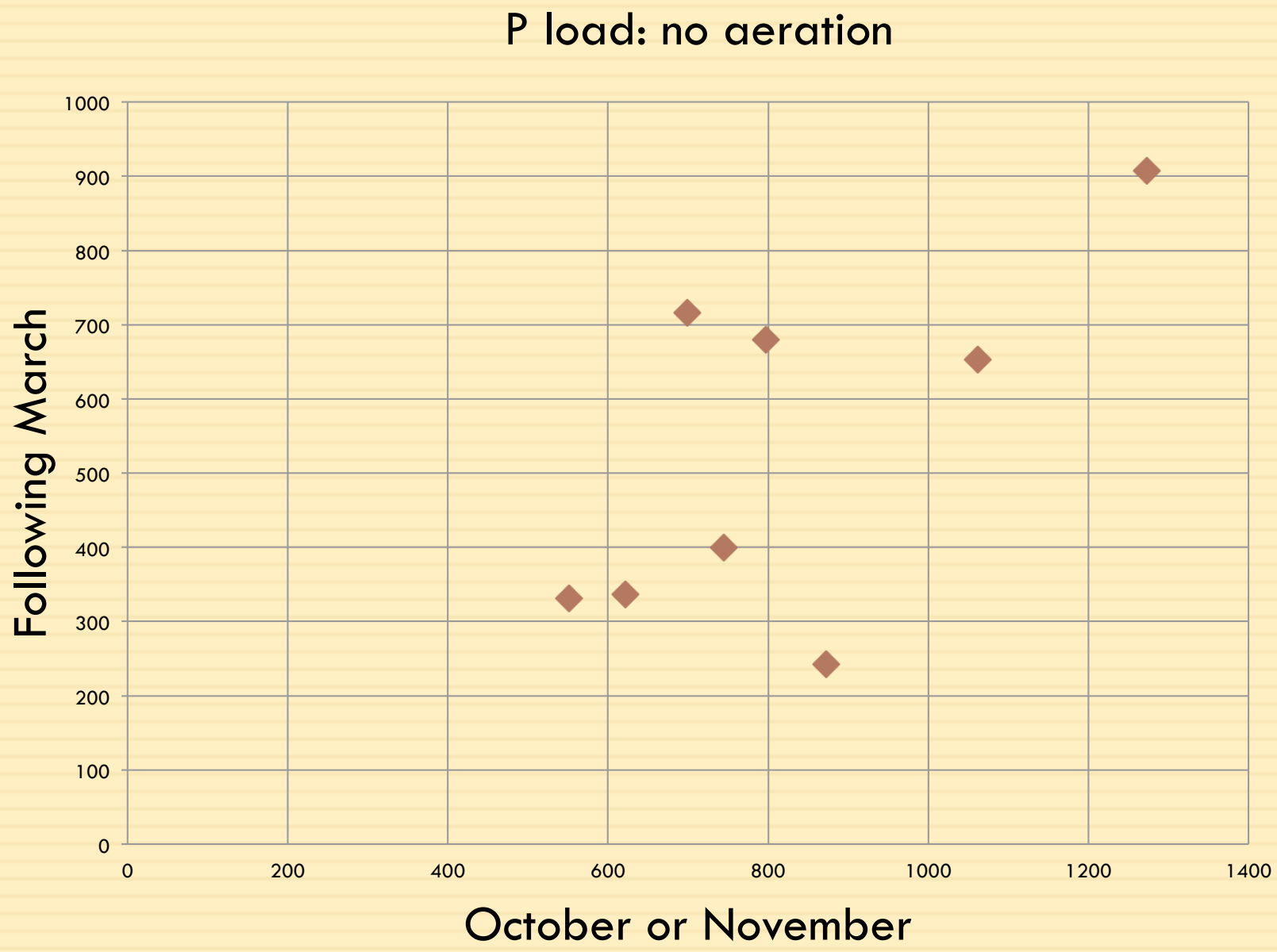
Part 3

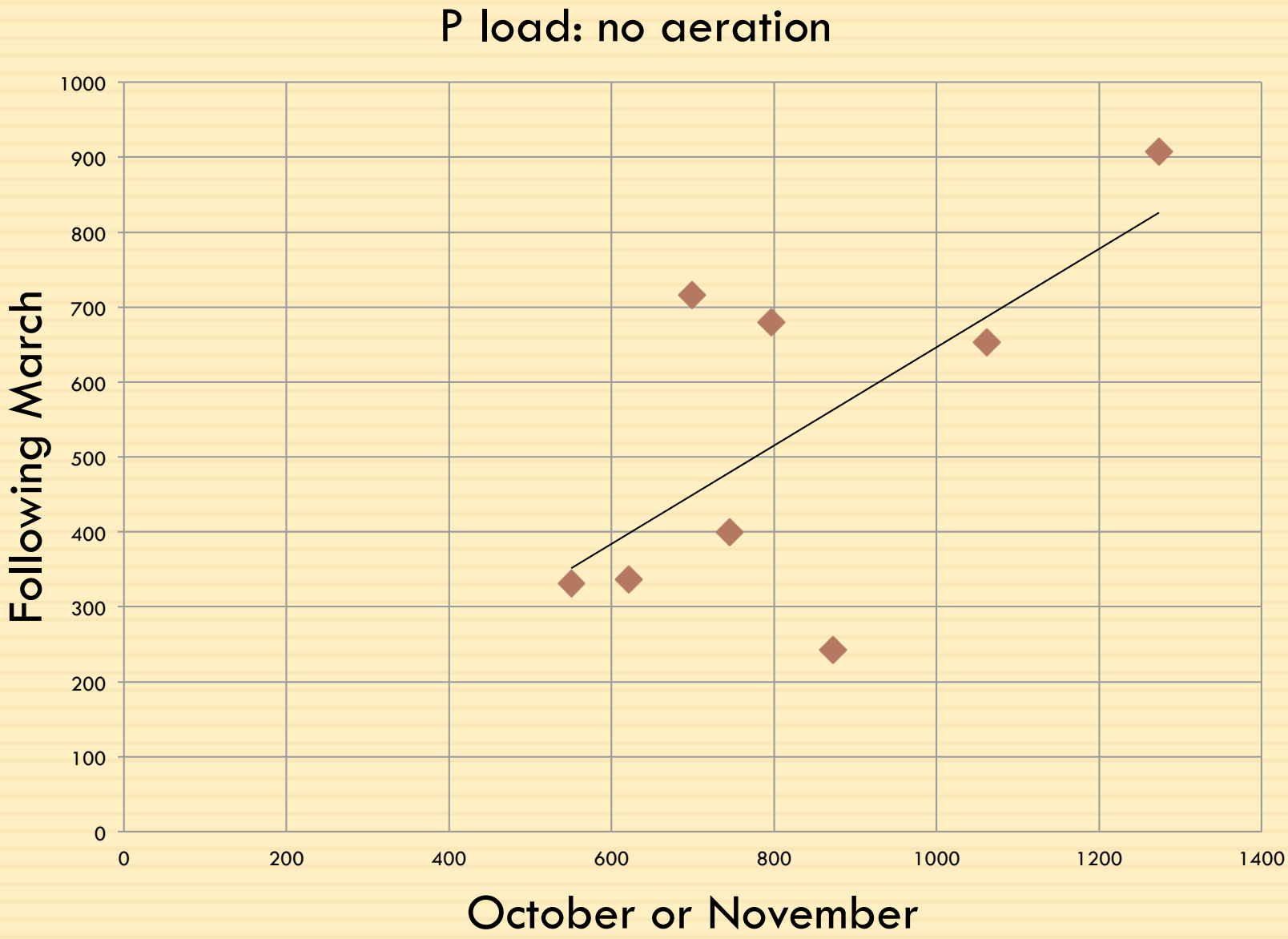
Loss of phosphorus during winter

Mostly by precipitation back into the sediment

Loss of P --- years of no aeration

	Oct-Nov	Following March
1979	699	716
1980	1062	653
1994	797	680
2005	1273	908
2006	872	243
2007	551	331
2008	621	337
2014	745	399 (Hodgins)


P load: no aeration
Following March
October or November
0
100
200
300
400
500
600
700
800
900
1000
0
200
400
600
800
1000
1200
1400


P load: no aeration
Following March
October or November
0
100
200
300
400
500
600
700
800
900
1000
0
200
400
600
800
1000
1200
1400

	Oct/Nov	Following March
No aeration		
1979	699	716
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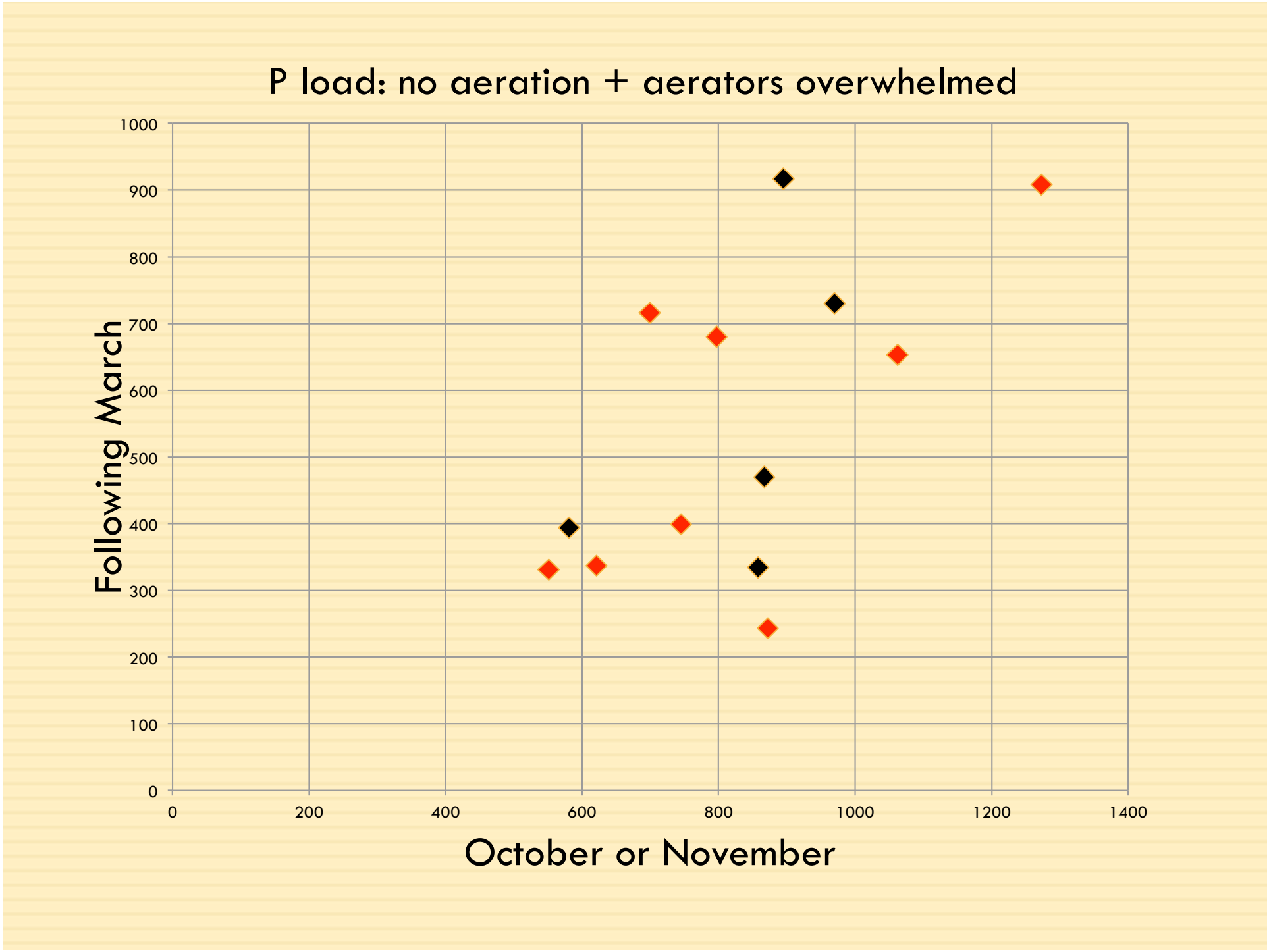
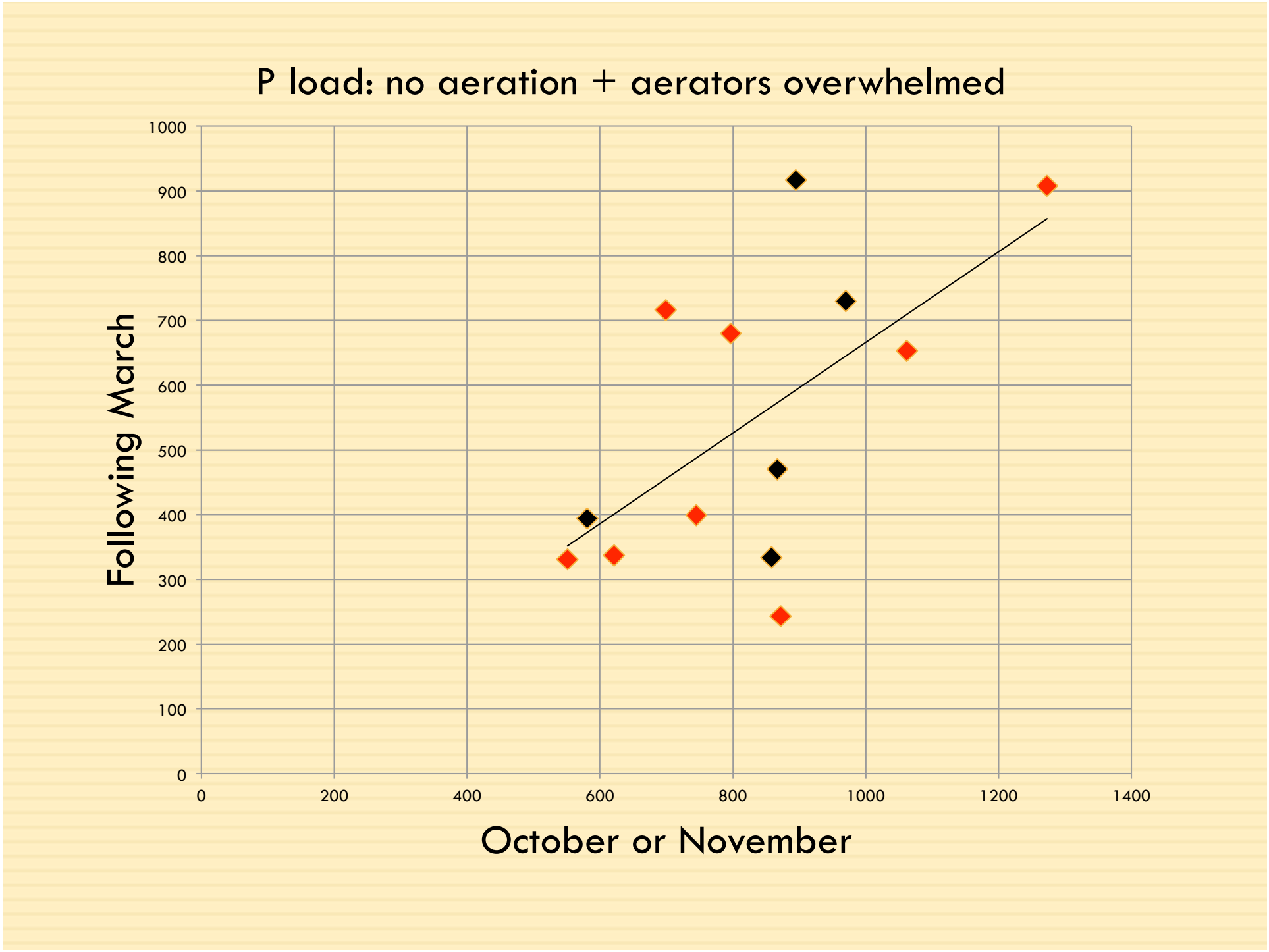
2005	1273	908
2006	872	243
2007	551	331
2008	621	337
2014	745	399
Aerators overwhelmed		
1986	581	394
1987	867	470
2011	895	917
2012	970	730
2013	858	334


P load: no aeration + aerators overwhelmed
Following March
October or November
0
100
200
300
400
500
600
700
800
900
1000
0
200
400
600
800
1000
1200
1400


P load: no aeration + aerators overwhelmed
Following March
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0
100
200
300
400
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600
700
800
900
1000
0
200
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1400

Side issue .... net P from sediment

- Take all the numbers from preceding graph

  ... average the loss over the winter

  ... assume that all P goes back into sediment
- The average disappearance is 285 kg.
- Previously we said that initial P from sediment was

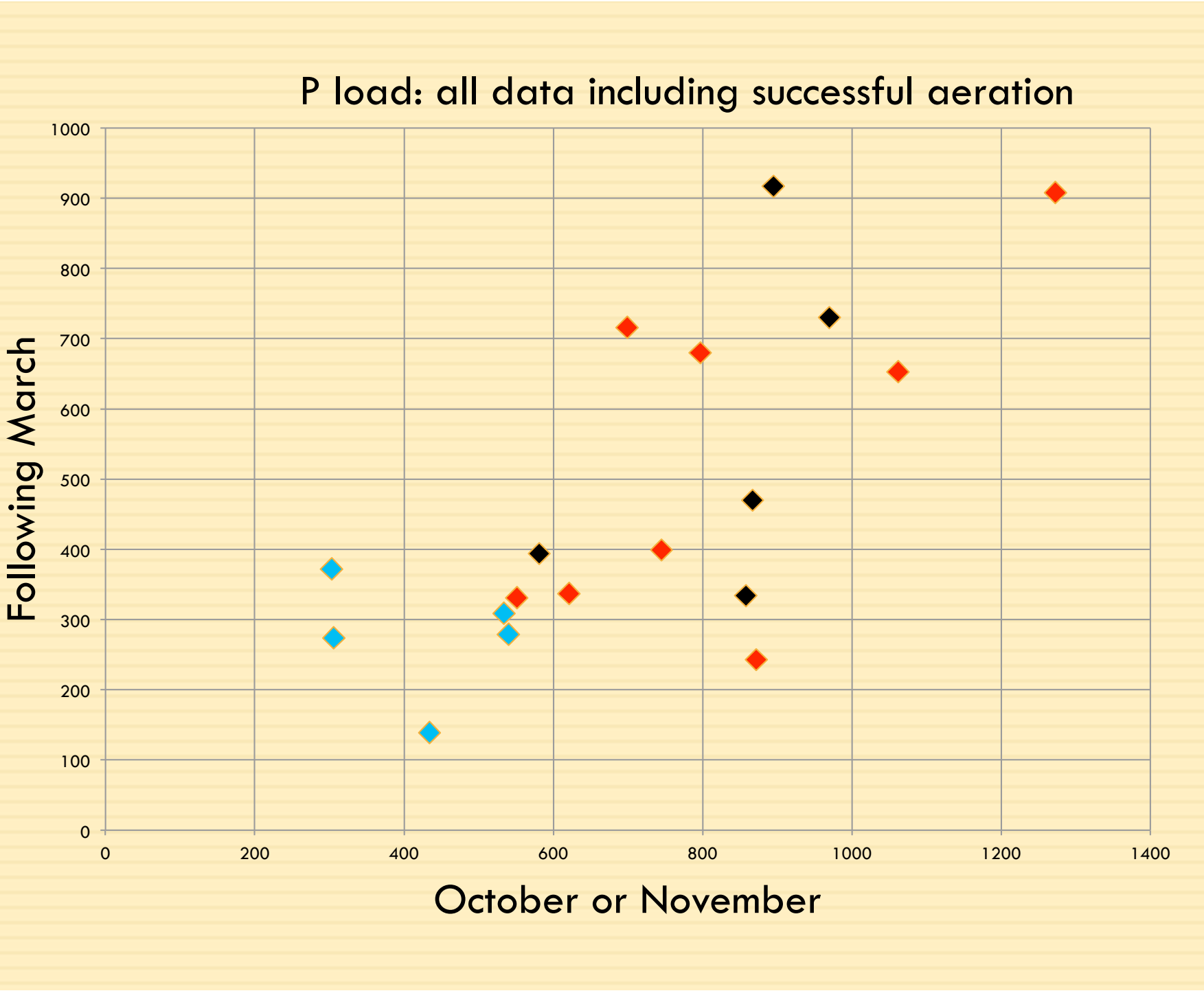
  400 to 450 kg.
- Subtracting,

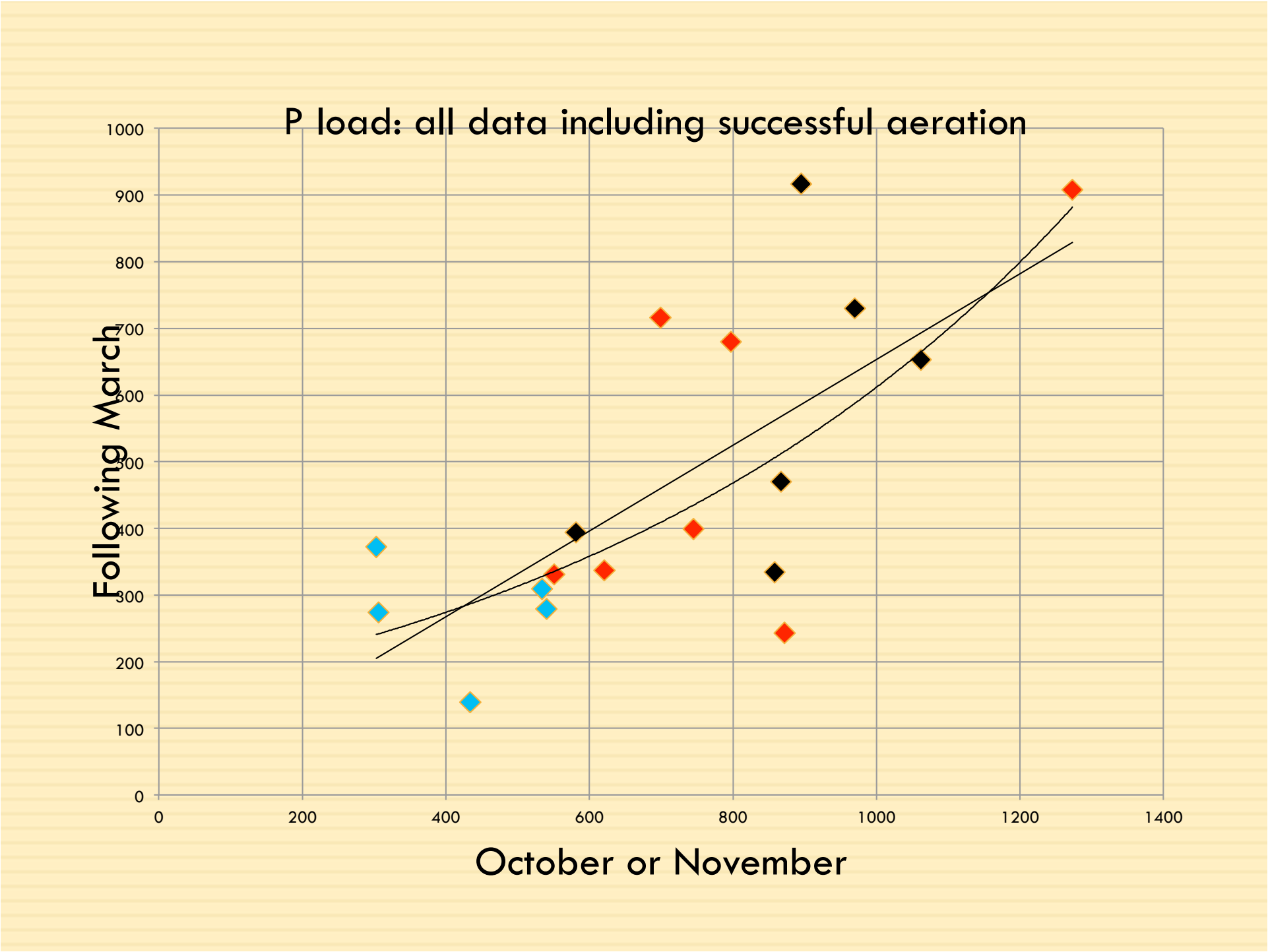
  net P from sediment is 115 to 165 kg

..... Net P from sediment

- Net sediment P = about 115 to 165 kg
- Larger amount than the small sources we considered at the beginning ....
- If we wish to improve the lake, this source deserves our focus.

	Oct/Nov	Following March
No aeration		
1979	699	716
1080	1062	653
1994	797	680
2005	1273	908
2006	872	243
2007	551	331
2008	621	337
2014	745	399
Aerators overwhelmed		
1986	581	394
1987	867	470
2011	895	917
2012	970	730
2013	858	334
Effective aeration		
1988	540	279
1989	306	274
1990	534	309
2009	434	139
2010	303	372


P load: all data including successful aeration
Following March
October or November
0
100
200
300
400
500
600
700
800
900
1000
0
200
400
600
800
1000
1200
1400


P load: all data including successful aeration
Following March
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1000
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200
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1400

Linear regression ?

- $Y = 10.049 + 0.6433X$

- So on average ....
  - 1200 kg P in the autumn
    should result in 782 kg next spring.... a loss of 35%
  - 800 kg P in the autumn
    should result in 525 kg next spring .... a loss of 34%.
  - 400 kg in autumn
    should result in 267 next spring .... a loss of 33%.

Conclusions ?

(1) Yes,

the springtime load of P is related to autumn P.

The relationship is variable but definite.

Conclusions ?

(2) The springtime load is expected to be
about 2/3 of the preceding autumn load.

(3) Therefore, a lower load in autumn will mean
less P going back into the sediments.

(4) Referring back to the last graph ...
We are talking decrease in 100s of kg of P ...
Not just that 50 kg (optimistic) from improving
the land runoff.

Speculation

- If successful reduction of P from the sediment were continued ....

we would expect the lake to gradually clean itself

.... improve its trophic status

.... less P accumulating in sediment to cause trouble in future years.

Recommendation

- The management plan should specify a study to determine why the aerators failed after two years of successful operation.

References

Hodgins, D.O. 2015. TAC working group meeting - Jan 7th. Follow-up notes. Document is a work in progress. Electronic document for Technical Advisory Committee of the Salt Spring Island Watershed Protection Authority. Feb 23, 2015, 10 p.

Nordin, R.N., C.J.P. McKean, J.H. Wiens, 1983. St. Mary Lake water quality: 1979-1981. Prov. of British Columbia, Ministry of Environment, Victoria, B.C. Report, 120 p. [File: 64.080302]

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