Effects of Entrainment and Temperature Increase on Phytoplankton: A Novel Use of HPLC Pigment and Particle Size Analyses.

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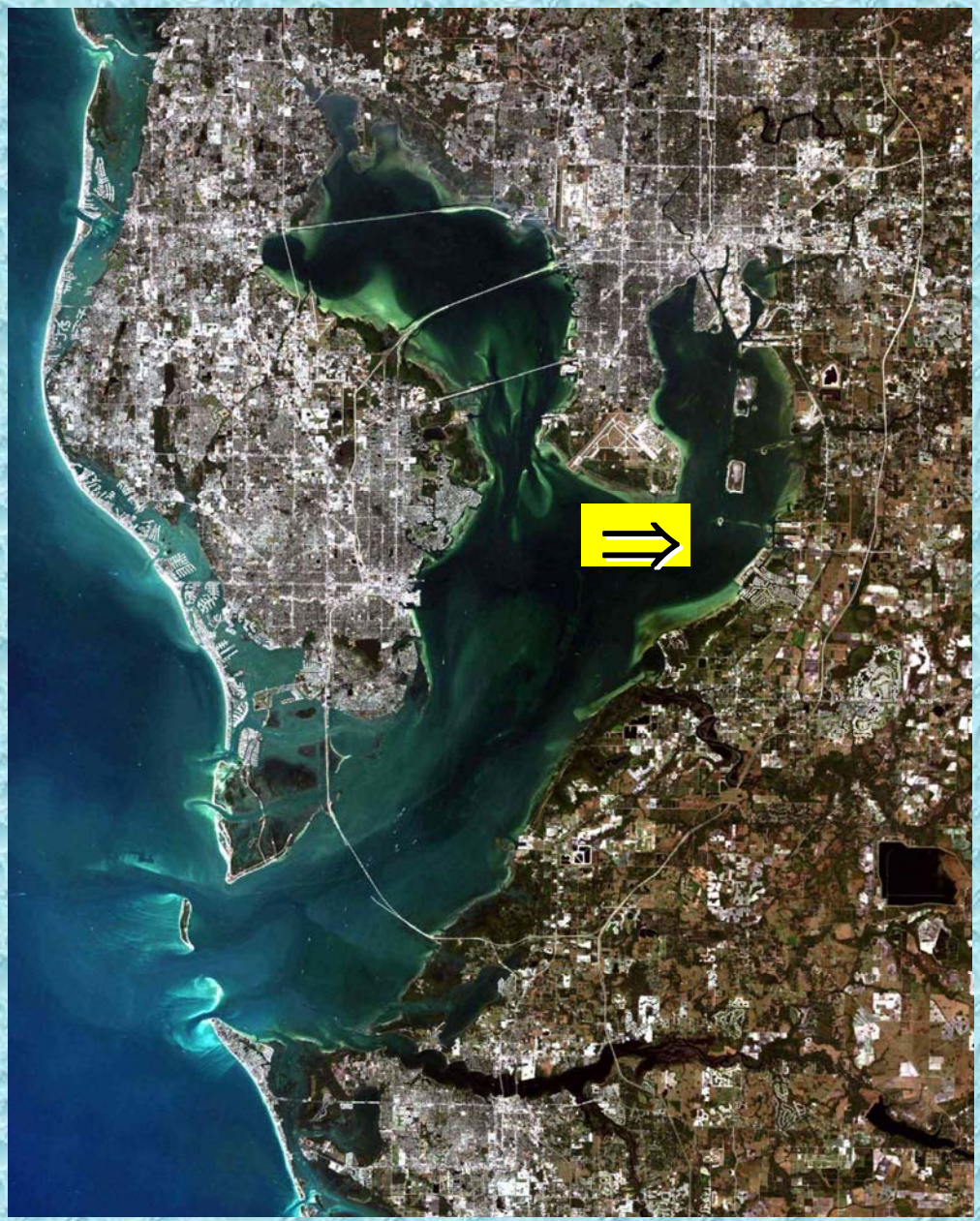
CENTER FOR COASTAL ECOLOGY



Big Bend Facility

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Big Bend Facility

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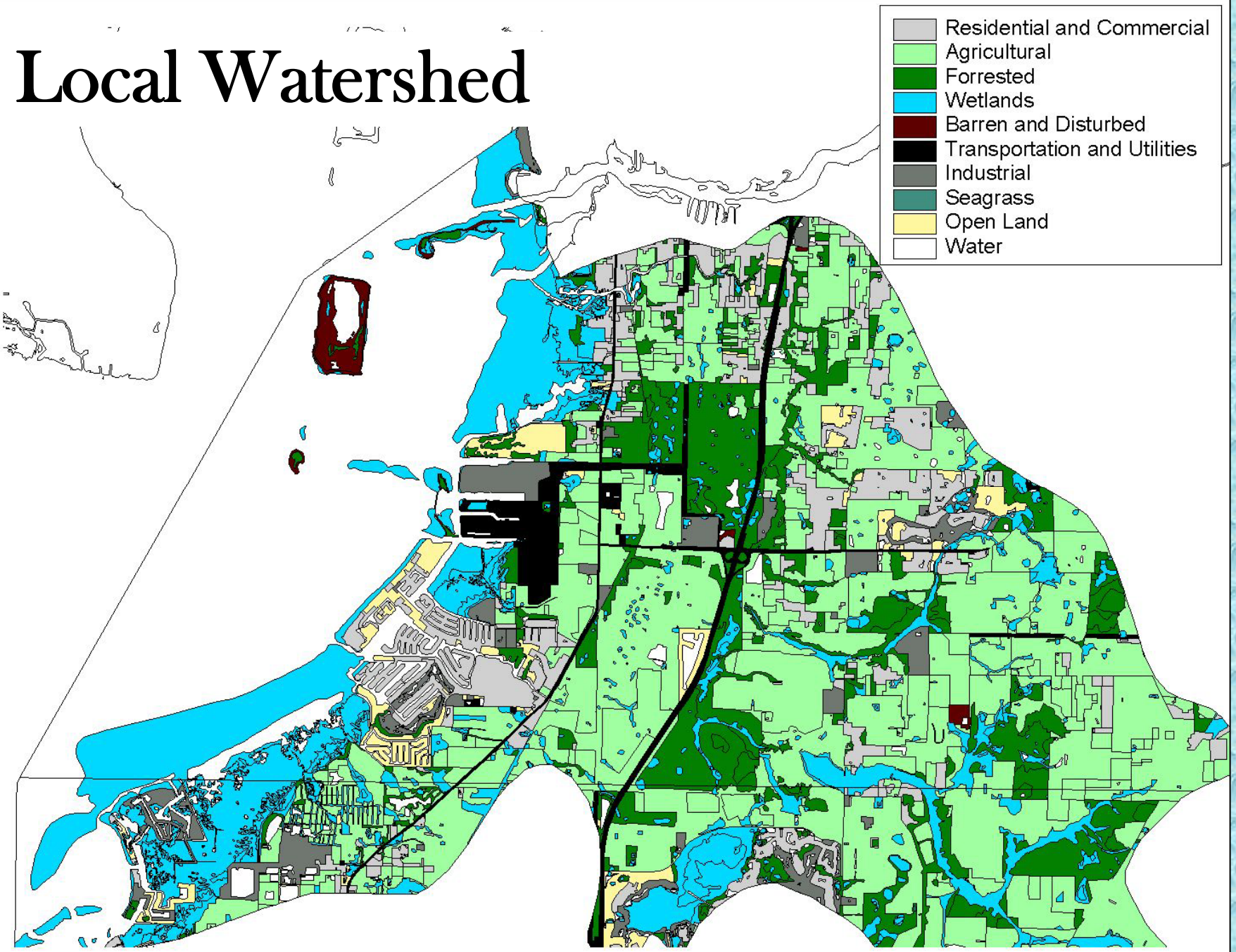
Local Watershed



Methods

1998 *1999*

May *September* *December* *March*

Sampling Sites

1) ***Intake Canal,***
2) ***Discharge Canal***
3) ***Thermal Area of the mixing zone,***
4) ***North Apollo Bay***
5) *South Control Area*

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Methods - continued

High Pressure Liquid Chromatography (HPLC) Pigment Analysis

Particle Size Analysis

- ***Multisizer IIe*** *(1.0 ☞m - 25 ☞m)*
- ***Coulter LS laser analyzer*** *(2 ☞m - 2000 ☞m)*

Total Suspended Solids *(TSS/TVS)*

–20 samples per station per quarter

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Effects of Facility on Plankton

Entrainment Effects

- Thermal, rapid temperature rise
- Mechanical, cell breakage

Post Entrainment Effects

- Thermal, elevated temperature area

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Objectives

To Measure

- Change in Particle Sizes

- Change in Phytoplankton Composition
  - *biomass*
  - *community composition*

- Relate to Temperature regime

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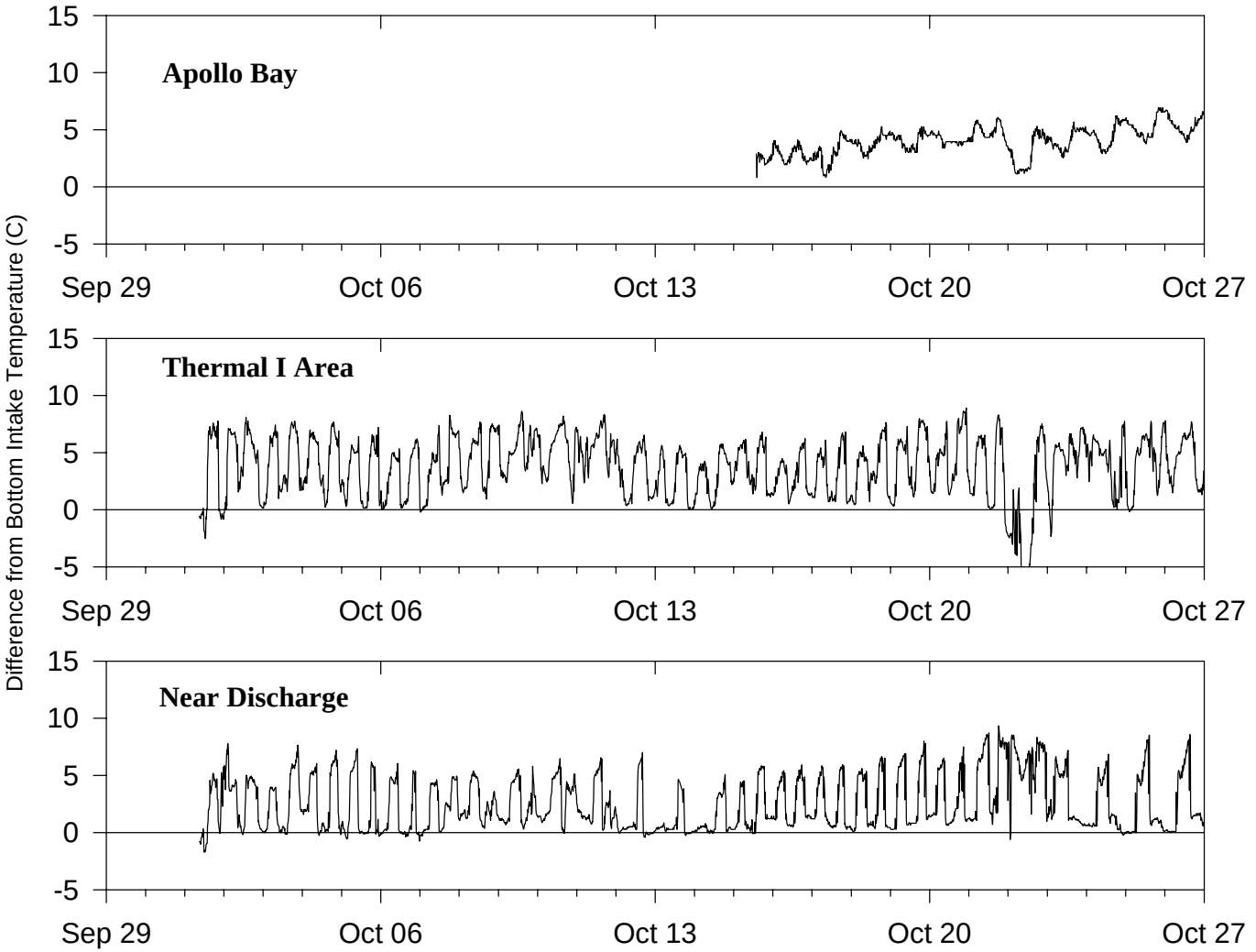
Temperature Regime



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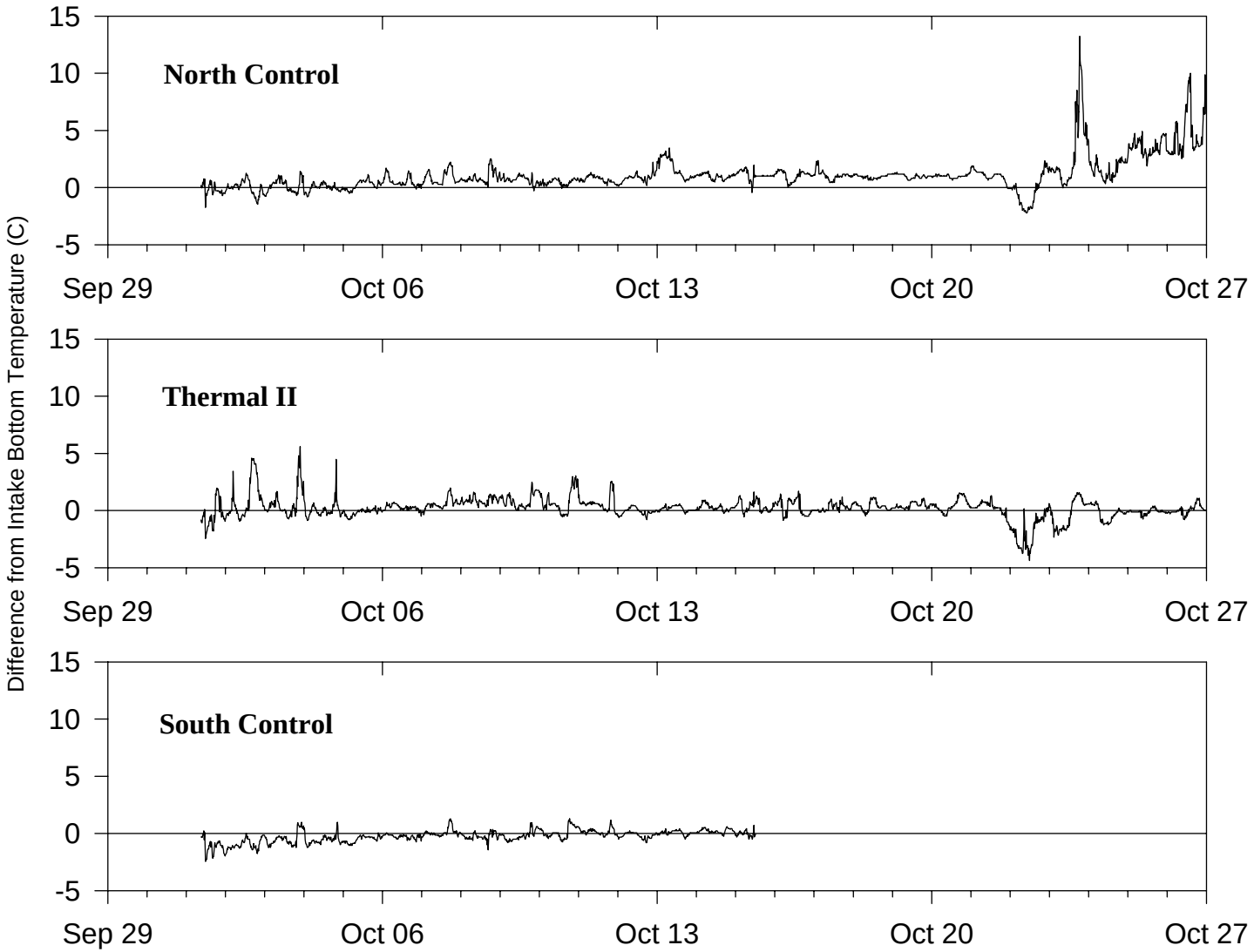
Temperature Regime



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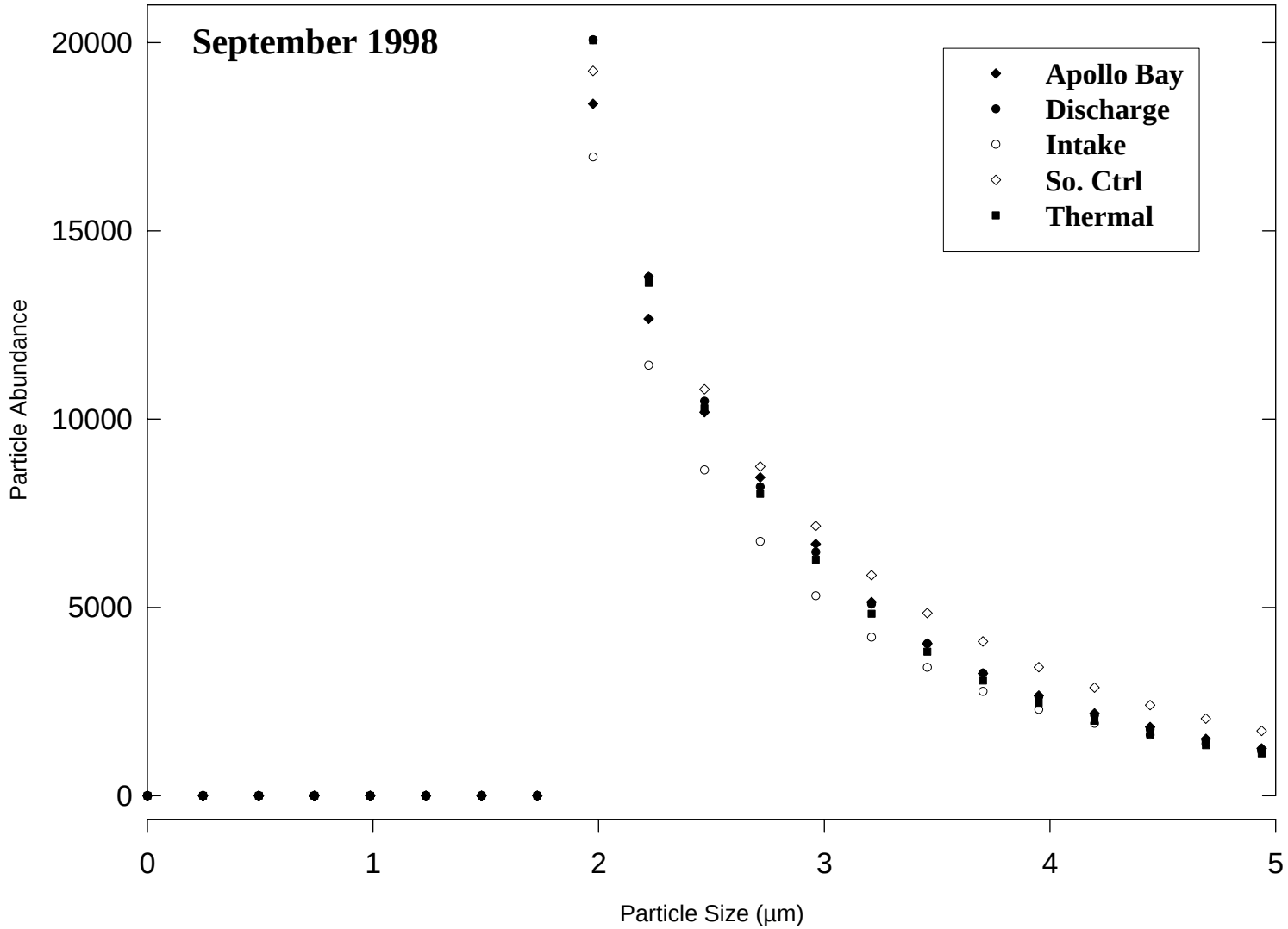
Particle Size Distribution



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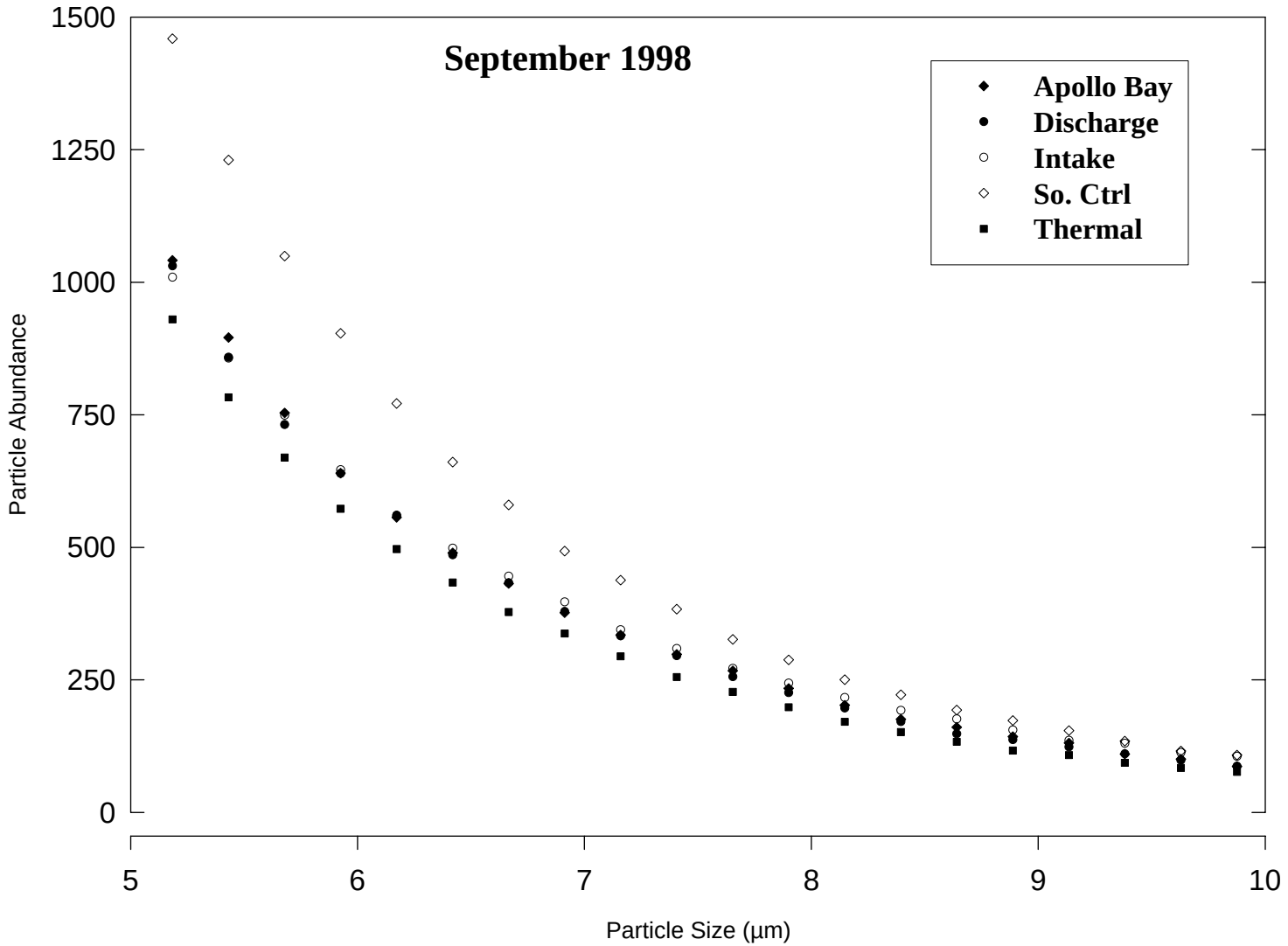
Particle Size Distribution



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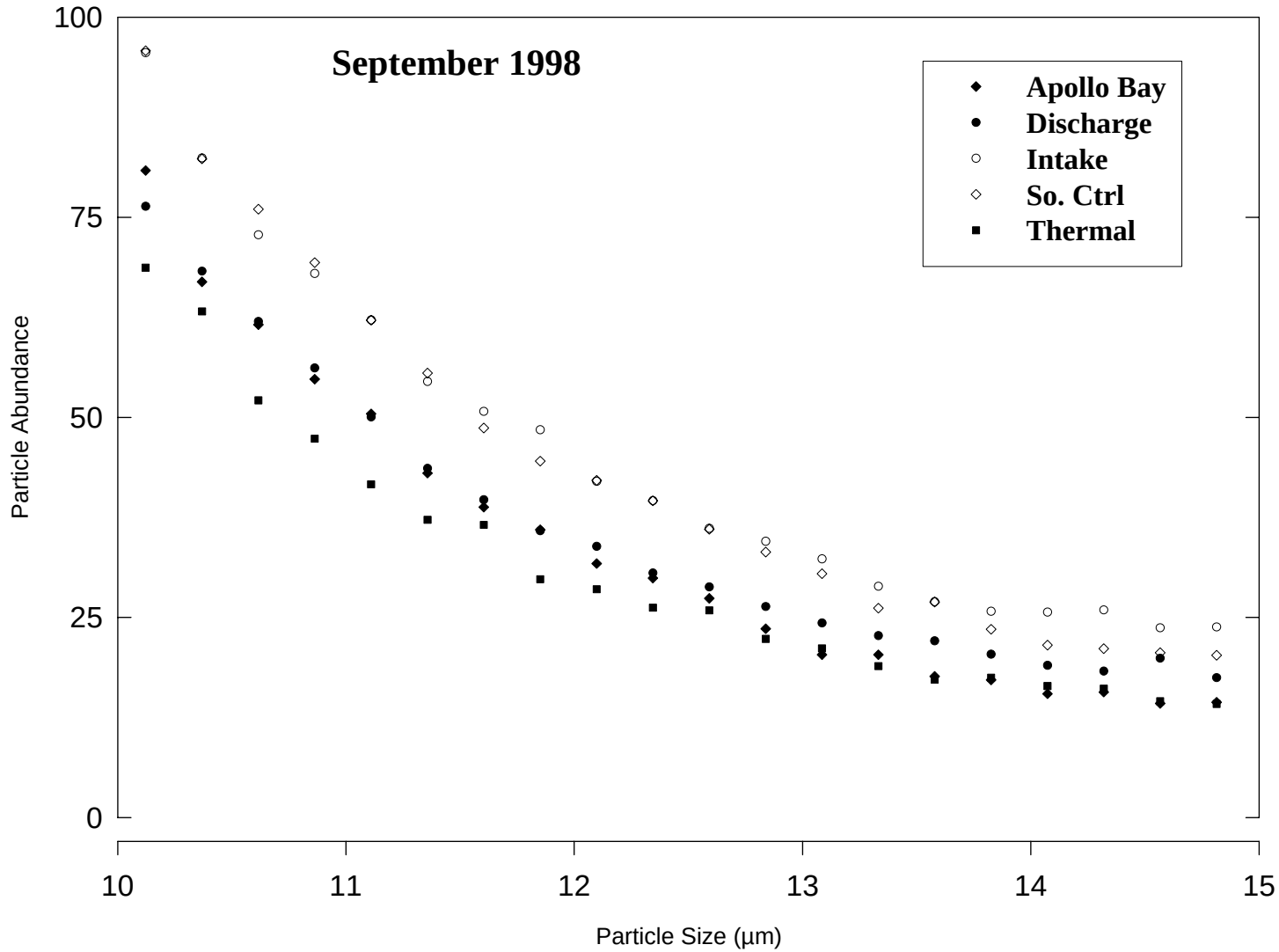
Particle Size Distribution



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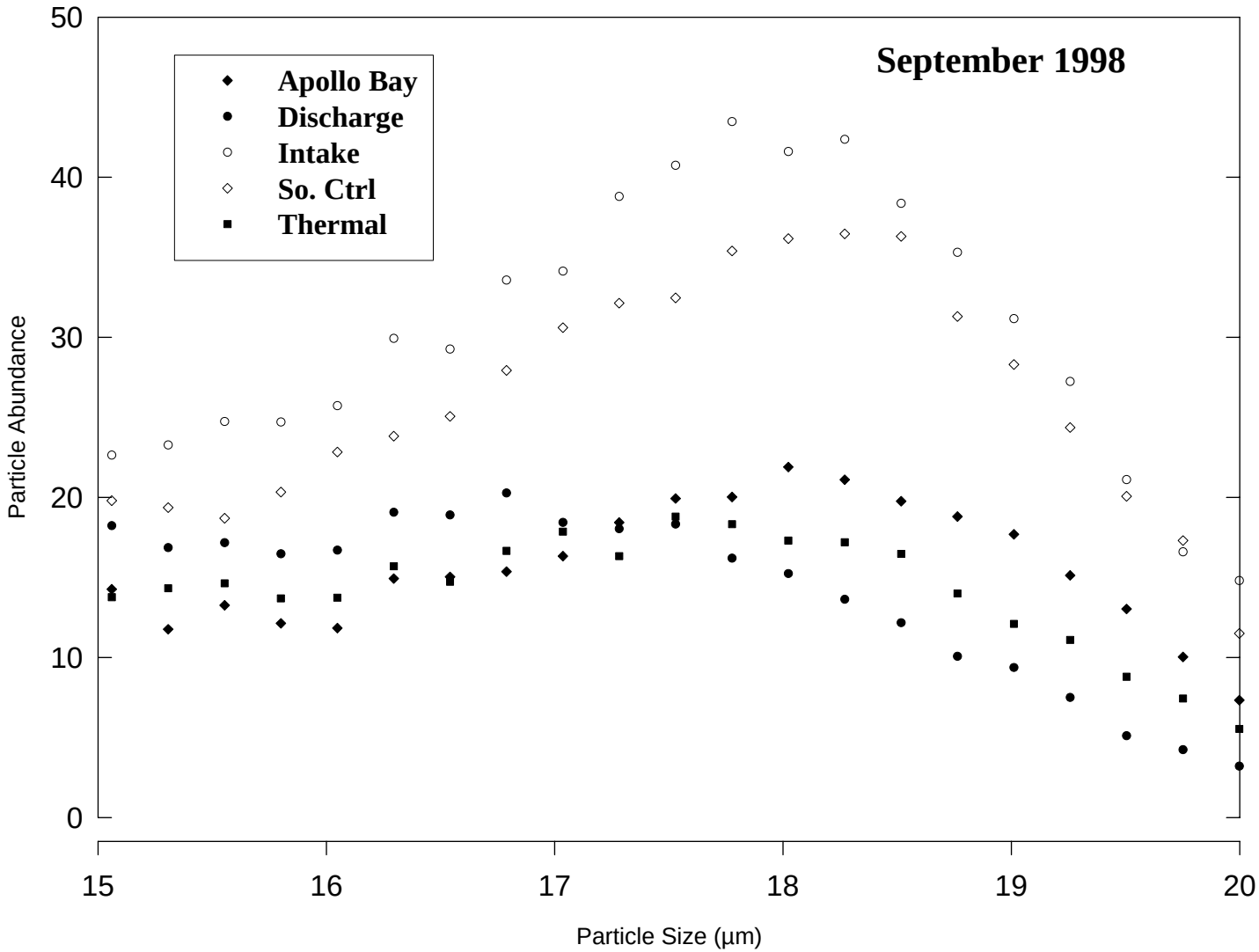
Particle Size Distribution



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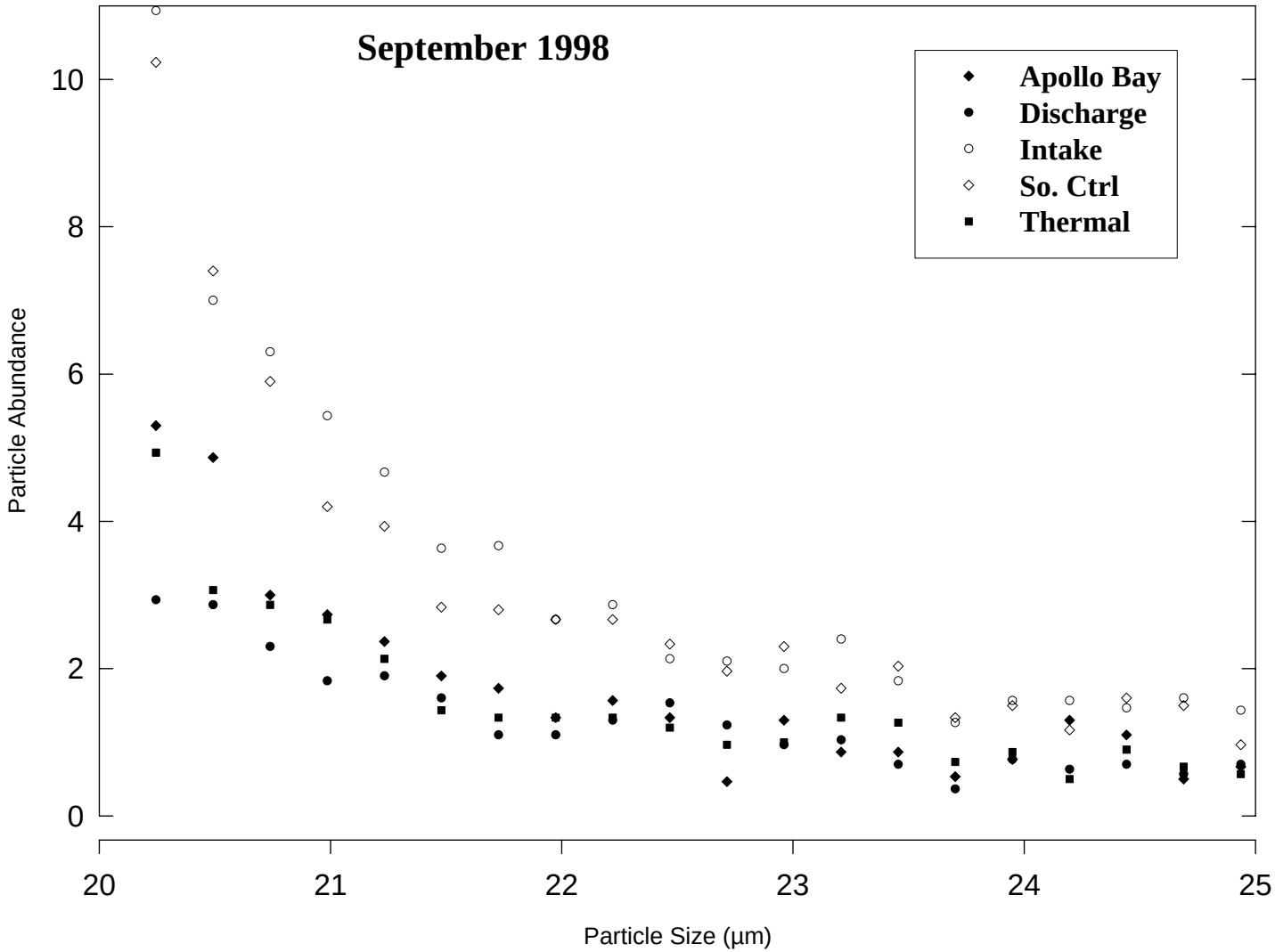
Particle Size Distribution



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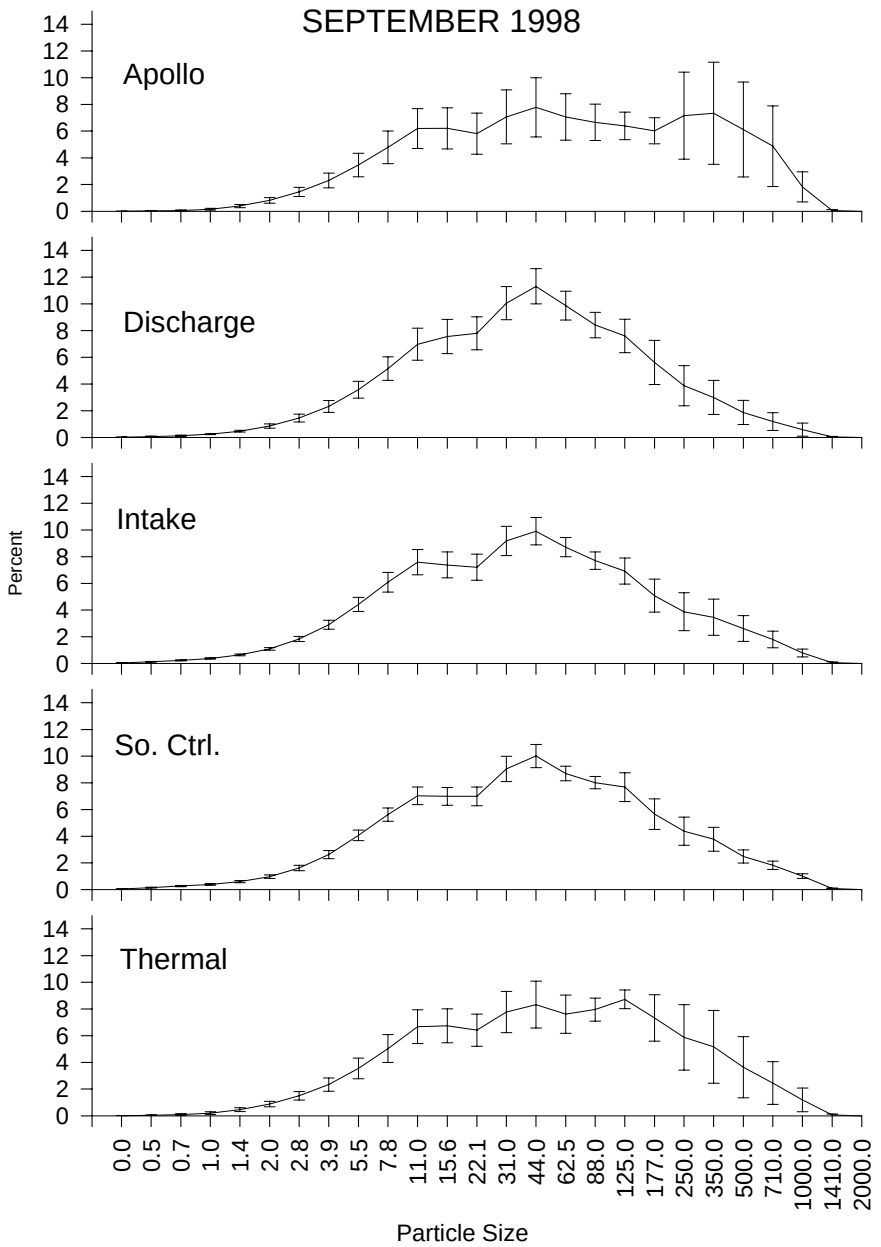

Particle Size Distribution Coulter LS

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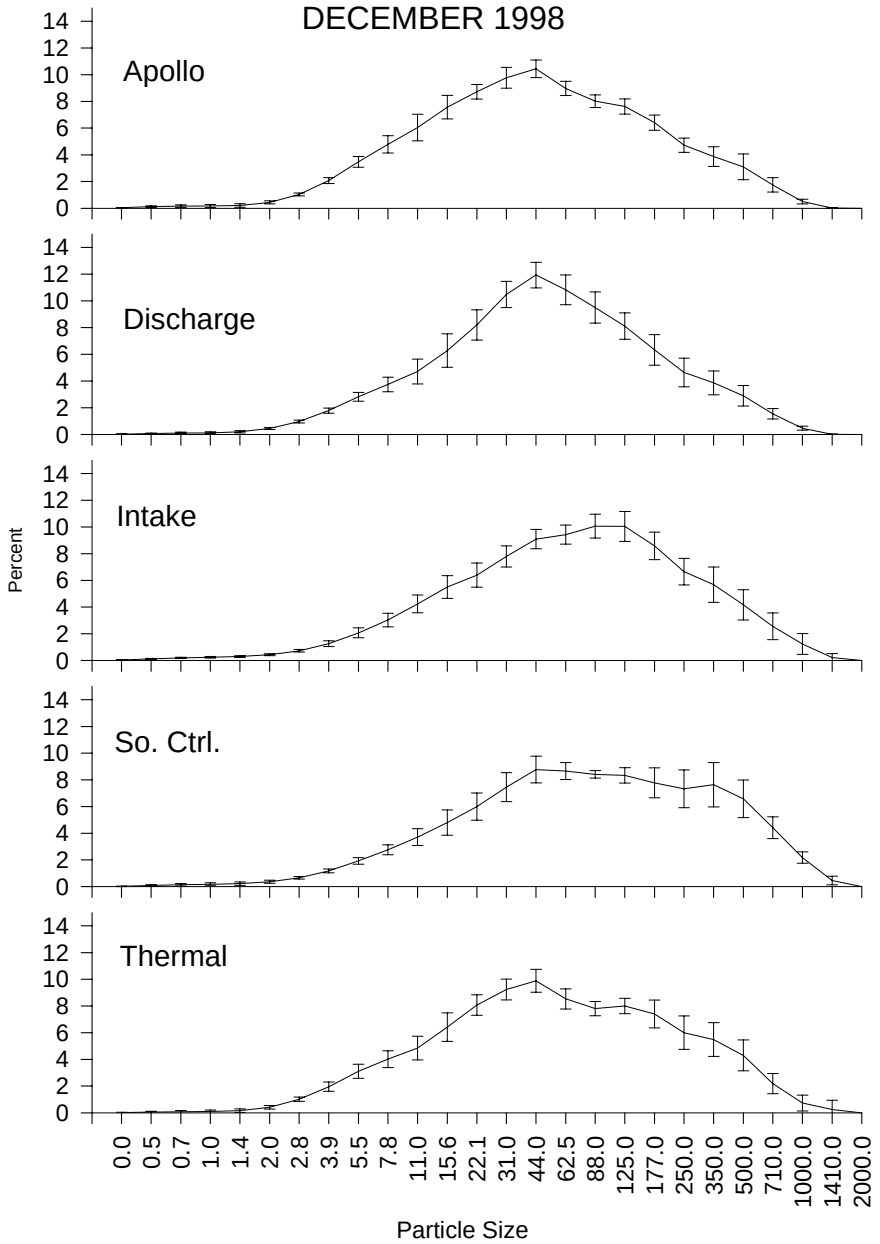

Particle Size Distribution Coulter LS

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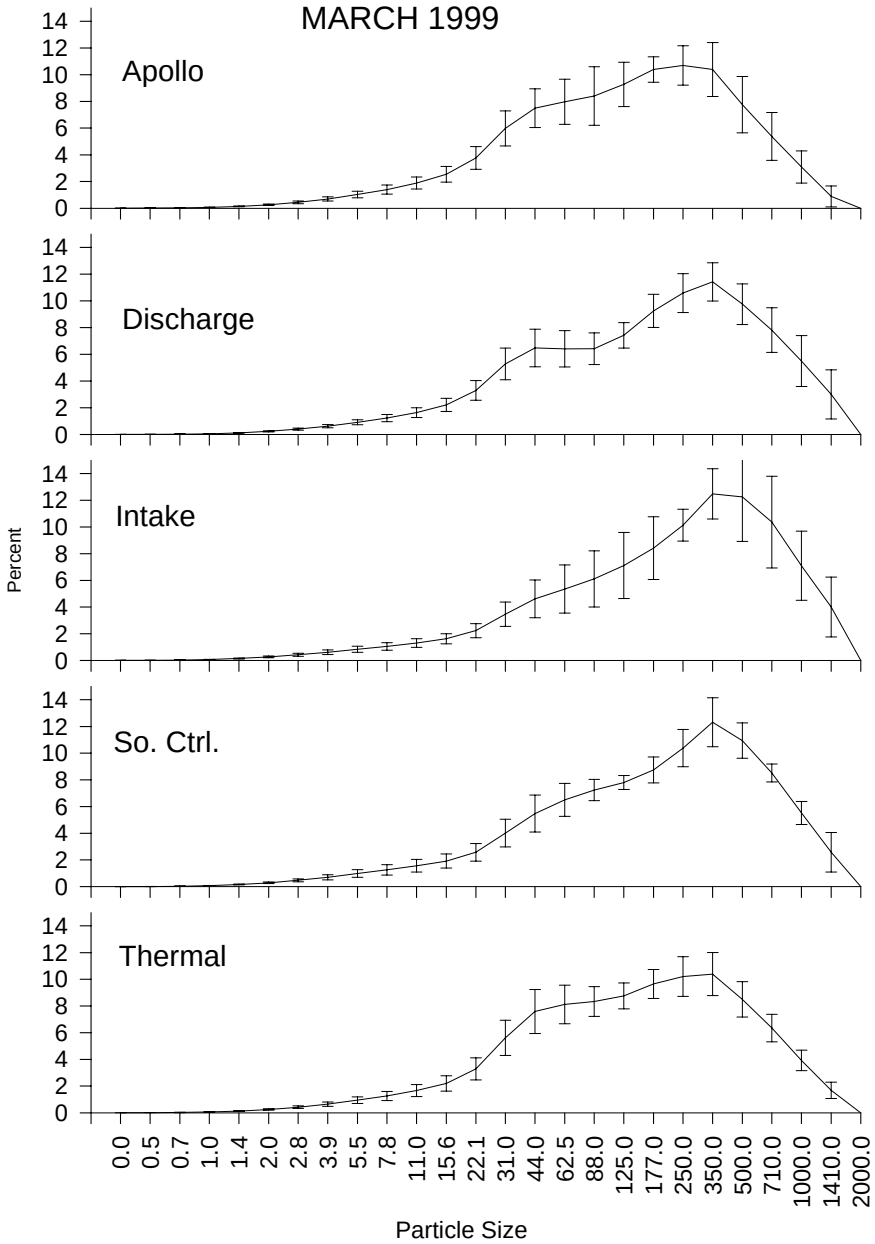

Particle Size Distribution Coulter LS

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HPLC - Photosynthetic Pigment Analysis

Eleven pigments differentiated by HPLC methodology (☞g/l values)

- chlorophyll a
- chlorophyll b
- diadinoxanthin
- diatoxanthin
- fucoxanthin
- alloxanthin
- 9'-CIS-xeoxanthin
- lutein
- peridinin
- violoxanthin
- zeaxanthin

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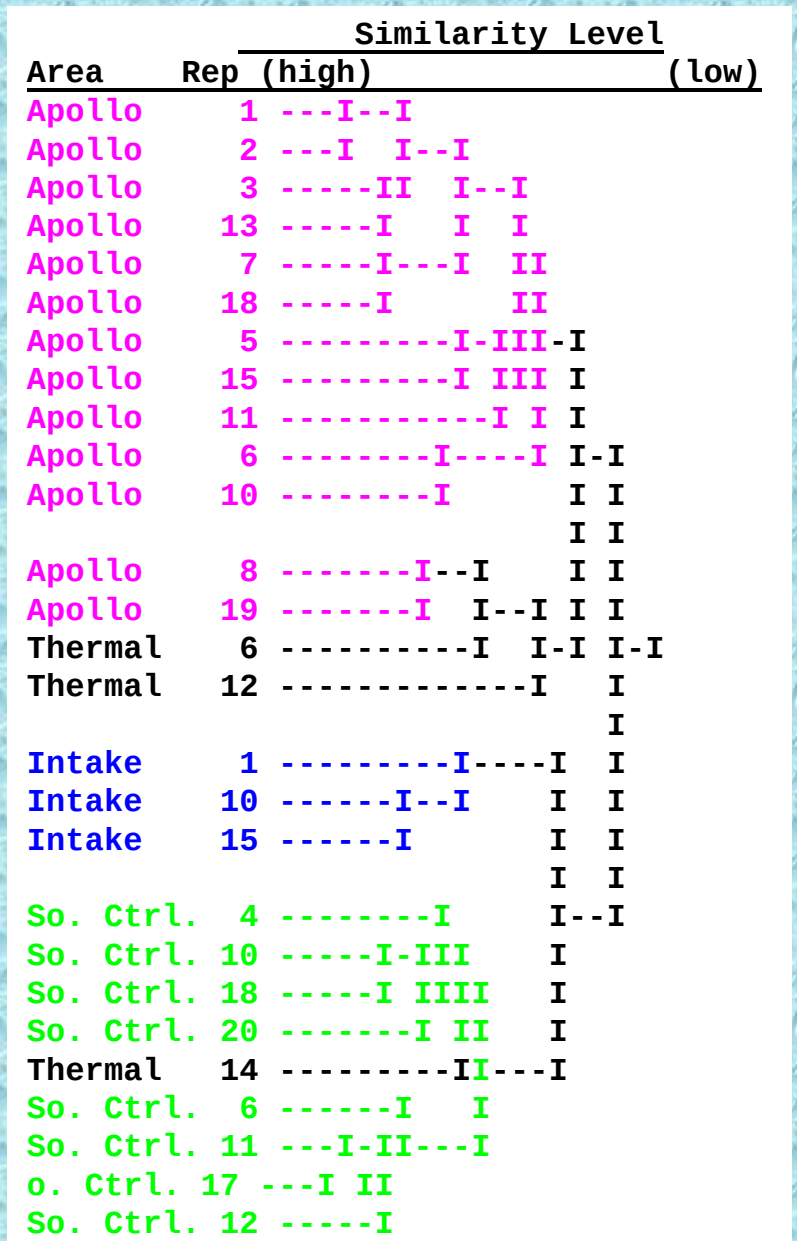
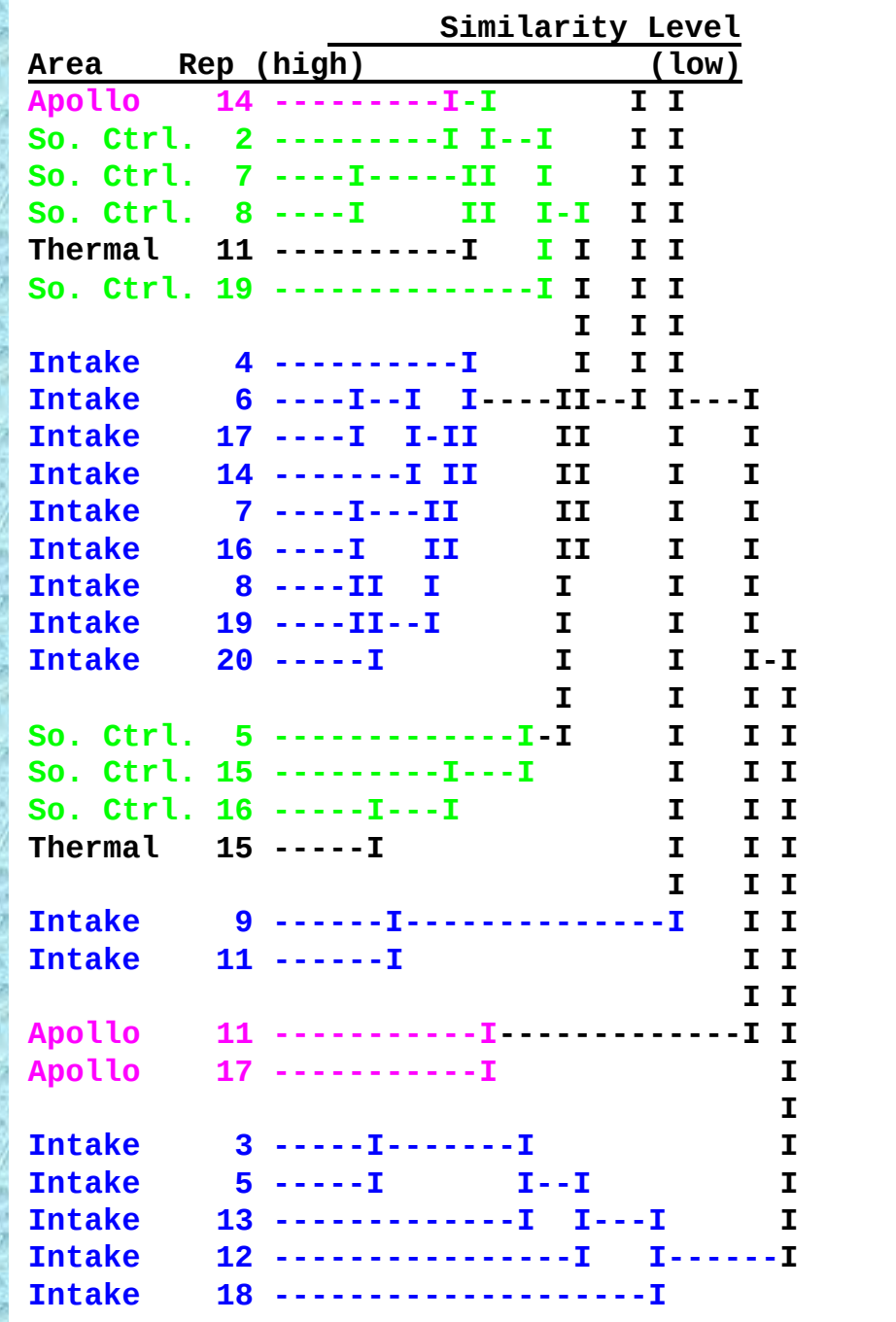
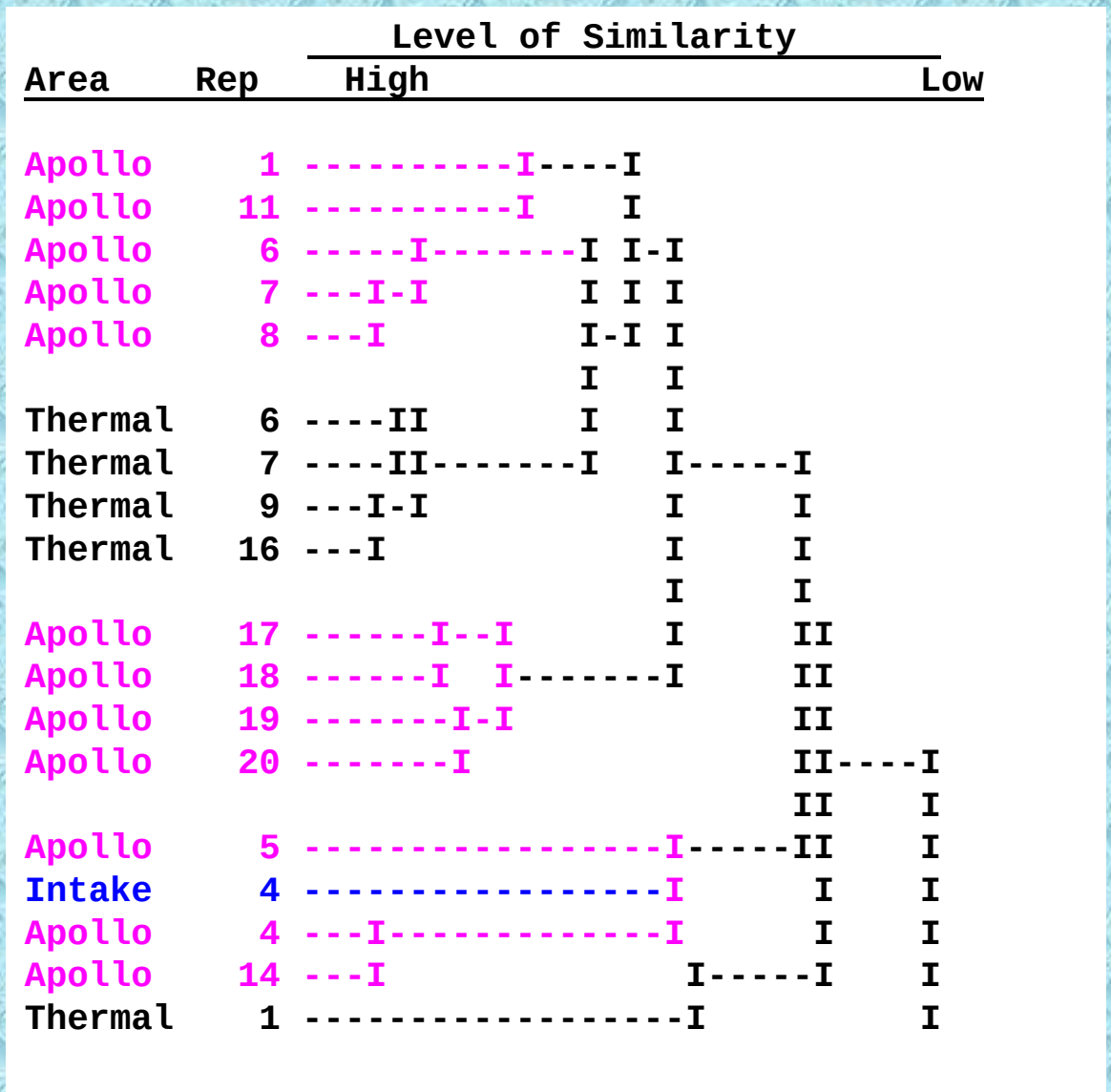
September

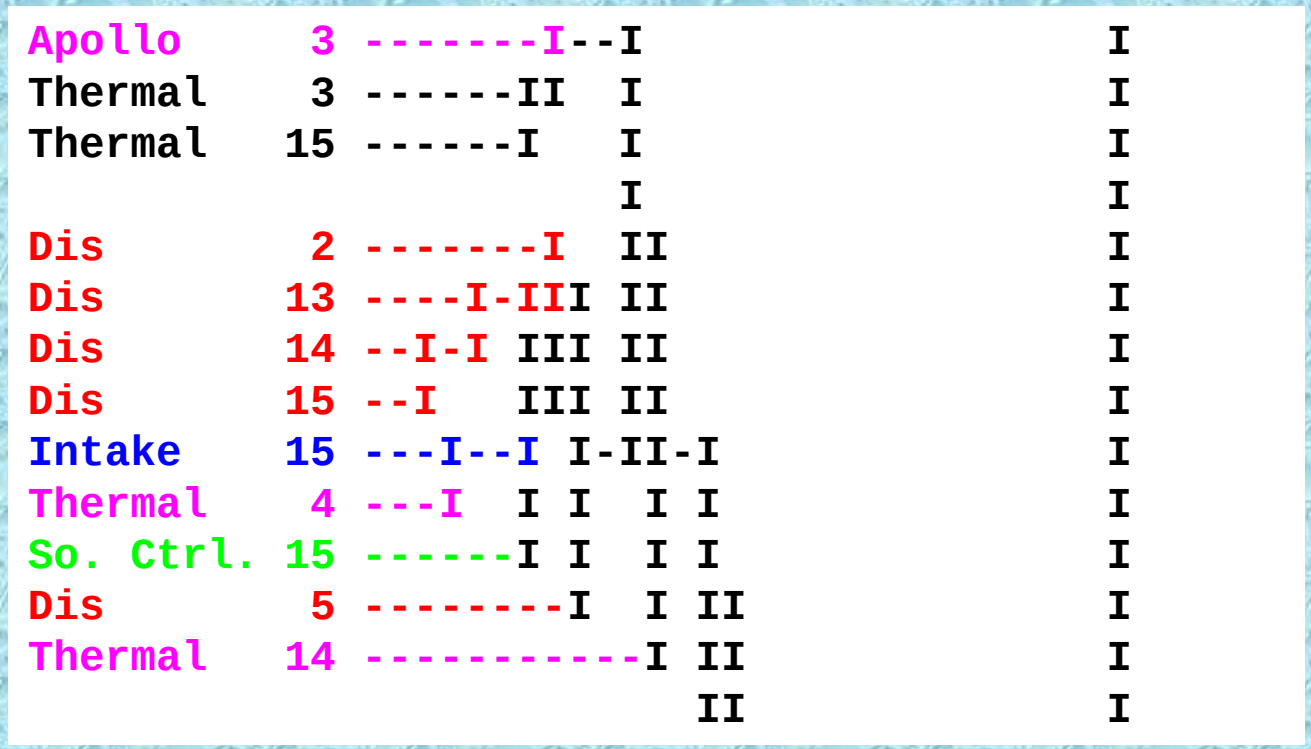

Similarity Level
Area Rep (high) (low)
Apollo 1
Apollo 2
Apollo 3
Apollo 13
Apollo 7
Apollo 18
Apollo 5
Apollo 15
Apollo 11
Apollo 6
Apollo 10
Apollo 8
Apollo 19
Thermal 6
Thermal 12
Intake 1
Intake 10
Intake 15
So. Ctrl. 4
So. Ctrl. 10
So. Ctrl. 18
So. Ctrl. 20
Thermal 14
So. Ctrl. 6
So. Ctrl. 11
o. Ctrl. 17
So. Ctrl. 12


Similarity Level
Area Rep (high) (low)
Apollo 14
So. Ctrl. 2
So. Ctrl. 7
So. Ctrl. 8
Thermal 11
So. Ctrl. 19
Intake 4
Intake 6
Intake 17
Intake 14
Intake 7
Intake 16
Intake 8
Intake 19
Intake 20
So. Ctrl. 5
So. Ctrl. 15
So. Ctrl. 16
Thermal 15
Intake 9
Intake 11
Apollo 11
Apollo 17
Intake 3
Intake 5
Intake 13
Intake 12
Intake 18

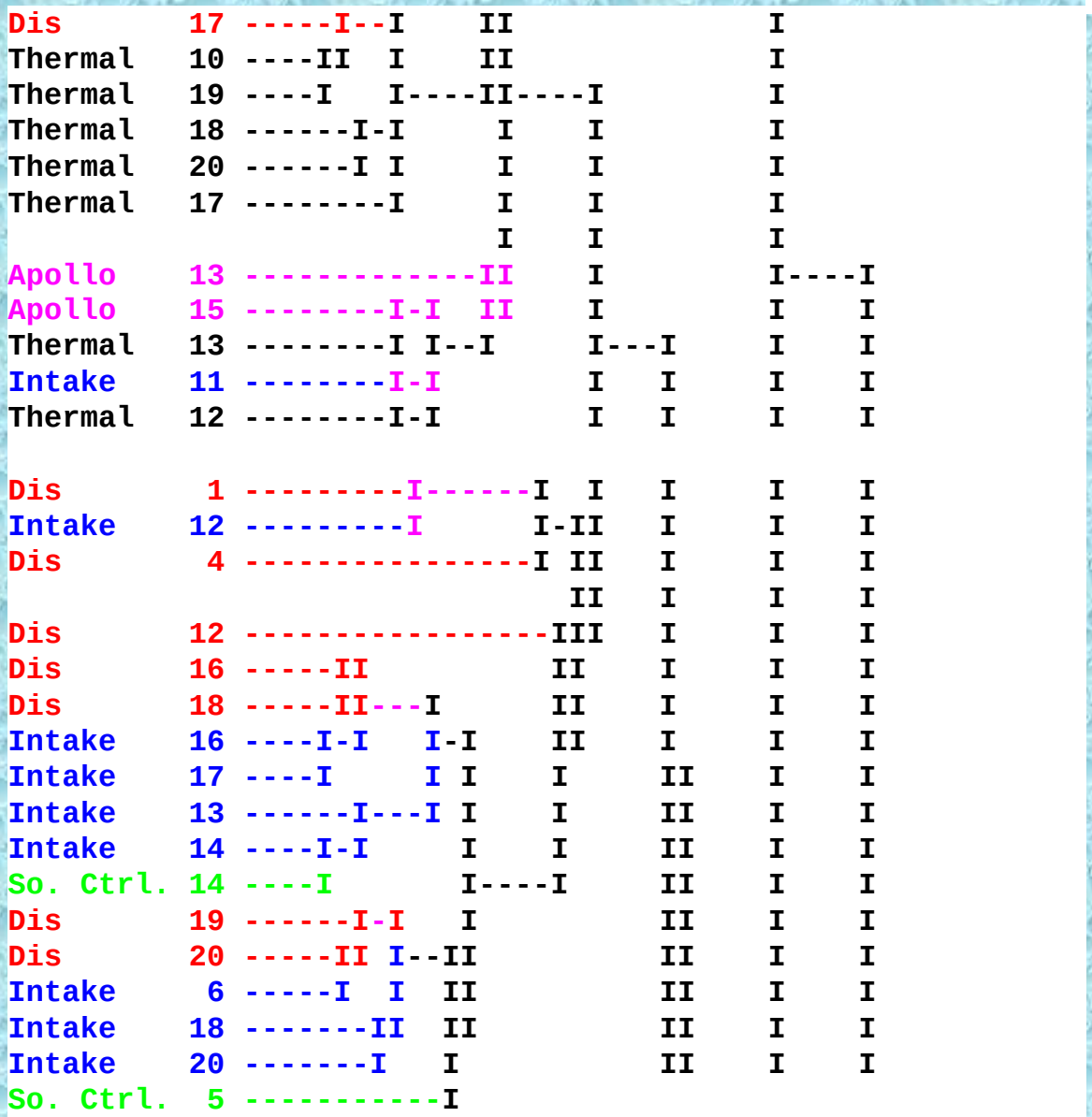
March


Level of Similarity
Area
Rep
High
Low
Apollo 1
Apollo 11
Apollo 6
Apollo 7
Apollo 8
Thermal 6
Thermal 7
Thermal 9
Thermal 16
Apollo 17
Apollo 18
Apollo 19
Apollo 20
Apollo 5
Intake 4
Apollo 4
Apollo 14
Thermal 1

March

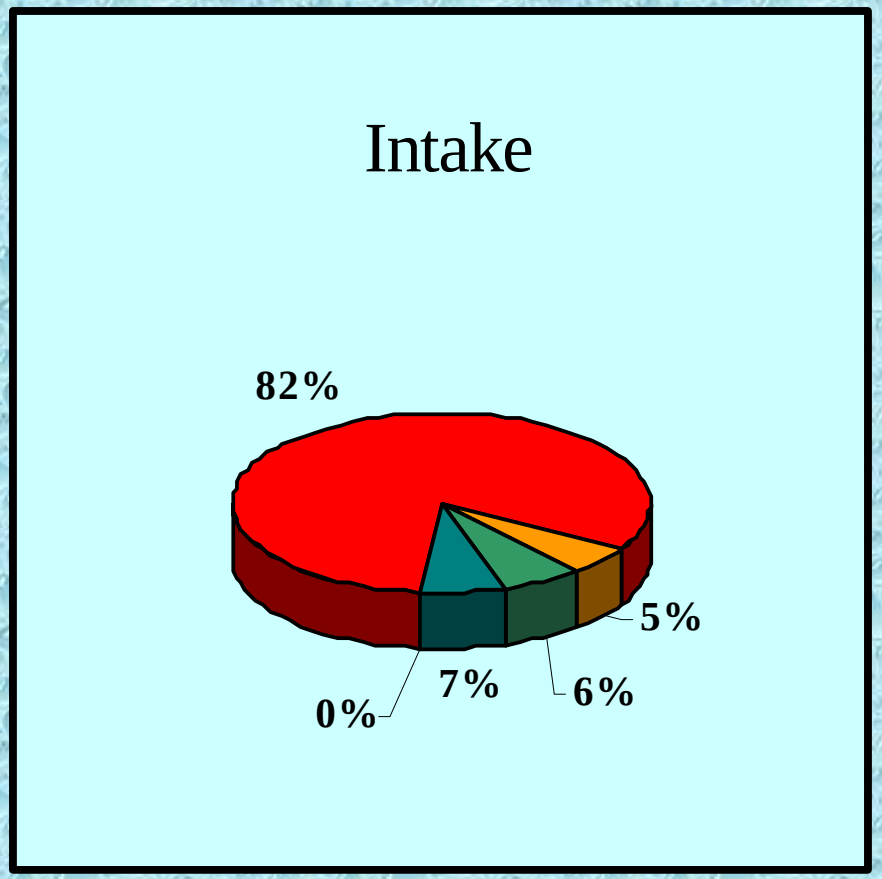

Apollo 3
Thermal 3
Thermal 15
Dis 2
Dis 13
Dis 14
Dis 15
Intake 15
Thermal 4
So. Ctrl. 15
Dis 5
Thermal 14

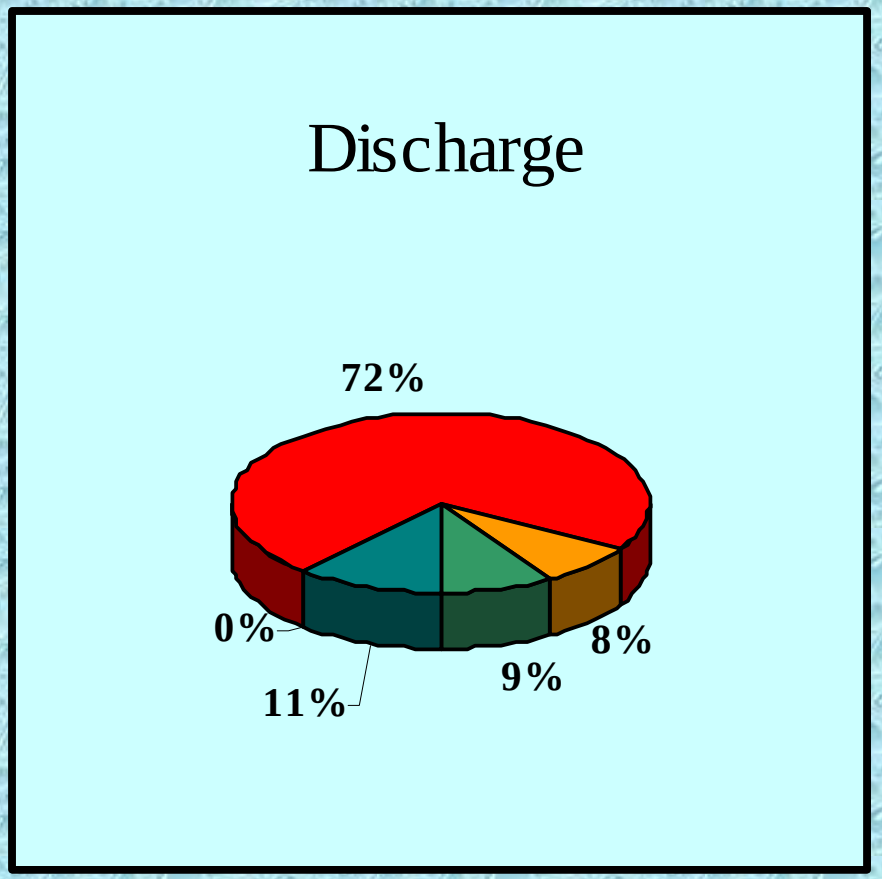
March


Dis 17
Thermal 10
Thermal 19
Thermal 18
Thermal 20
Thermal 17
Apollo 13
Apollo 15
Thermal 13
Intake 11
Thermal 12
Dis 1
Intake 12
Dis 4
Dis 12
Dis 16
Dis 18
Intake 16
Intake 17
Intake 13
Intake 14
So. Ctrl. 14
Dis 19
Dis 20
Intake 6
Intake 18
Intake 20
So. Ctrl. 5

Phytoplankton Composition - September

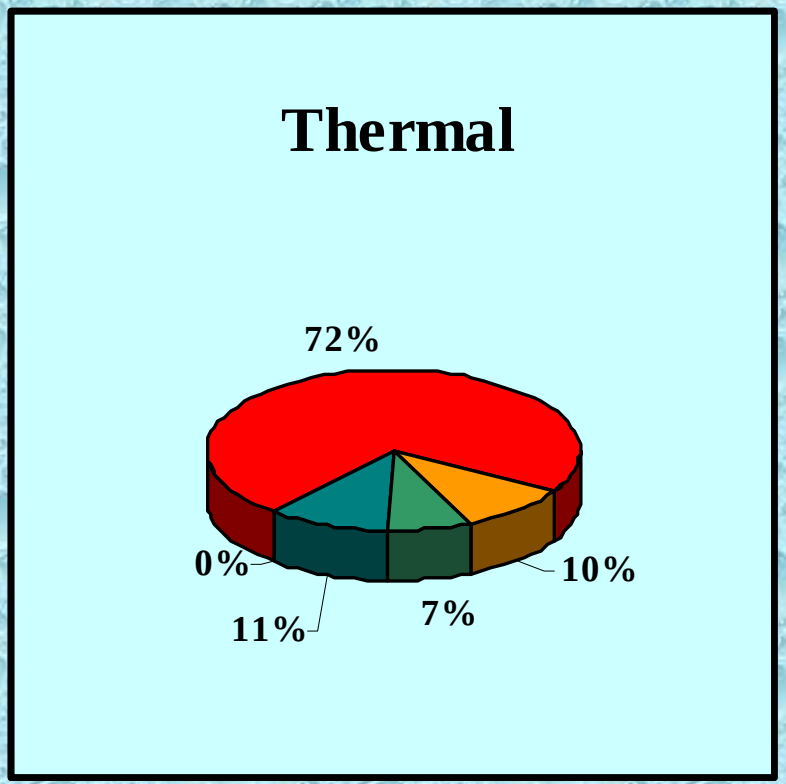
Diatoms, Chlorophytes, Cryptophytes, Cyanobacteria, Dinoflagellates

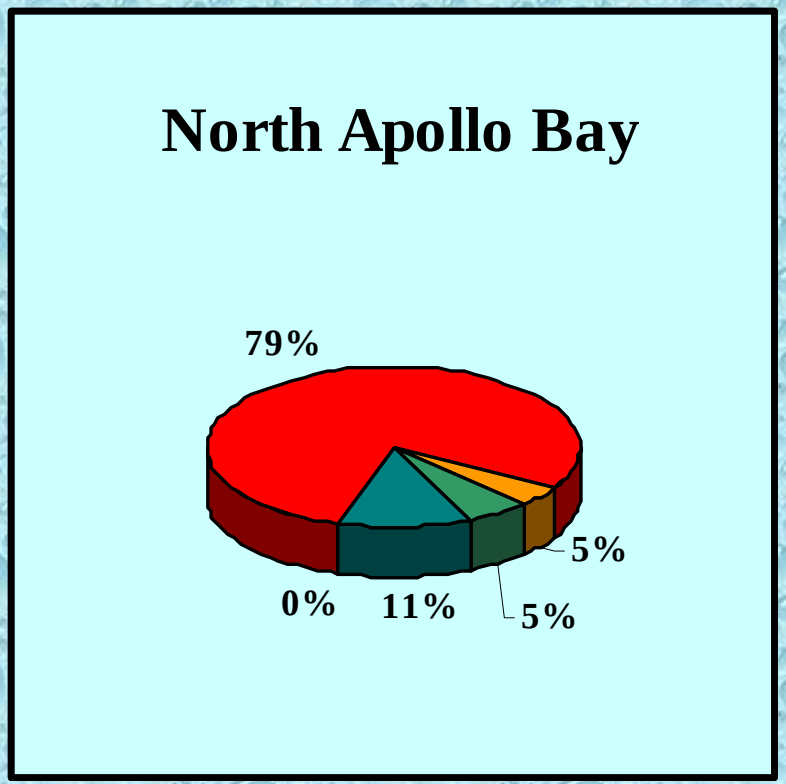




Phytoplankton Composition - September

Diatoms, Chlorophytes, Cryptophytes, Cyanobacteria, Dinoflagellates





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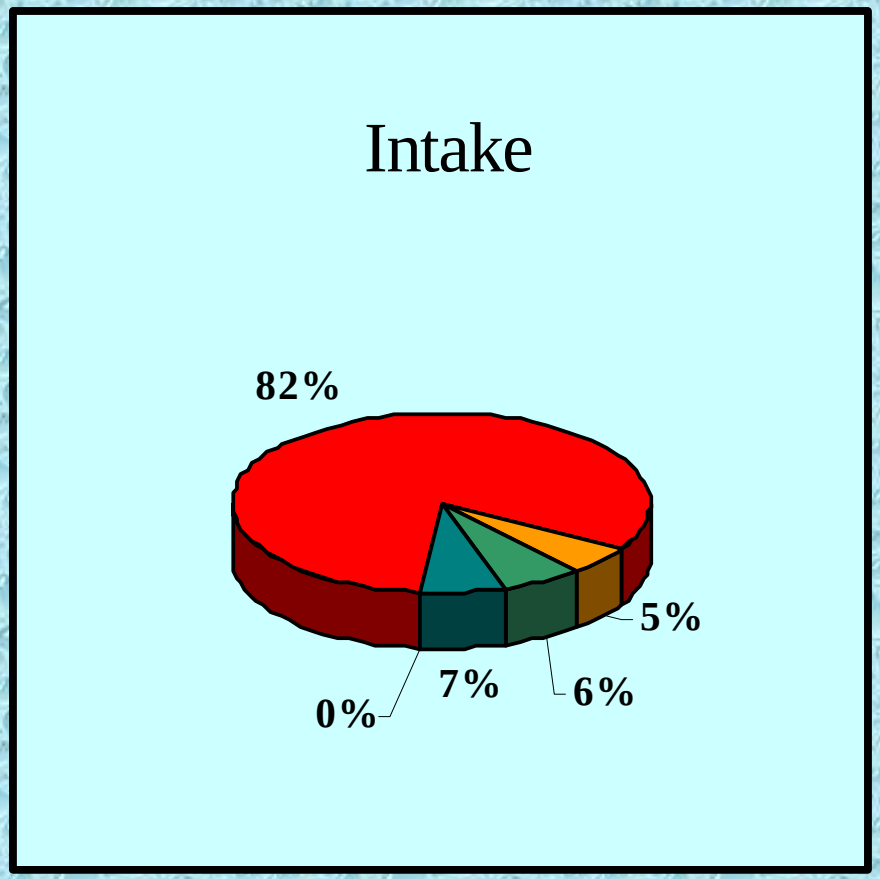
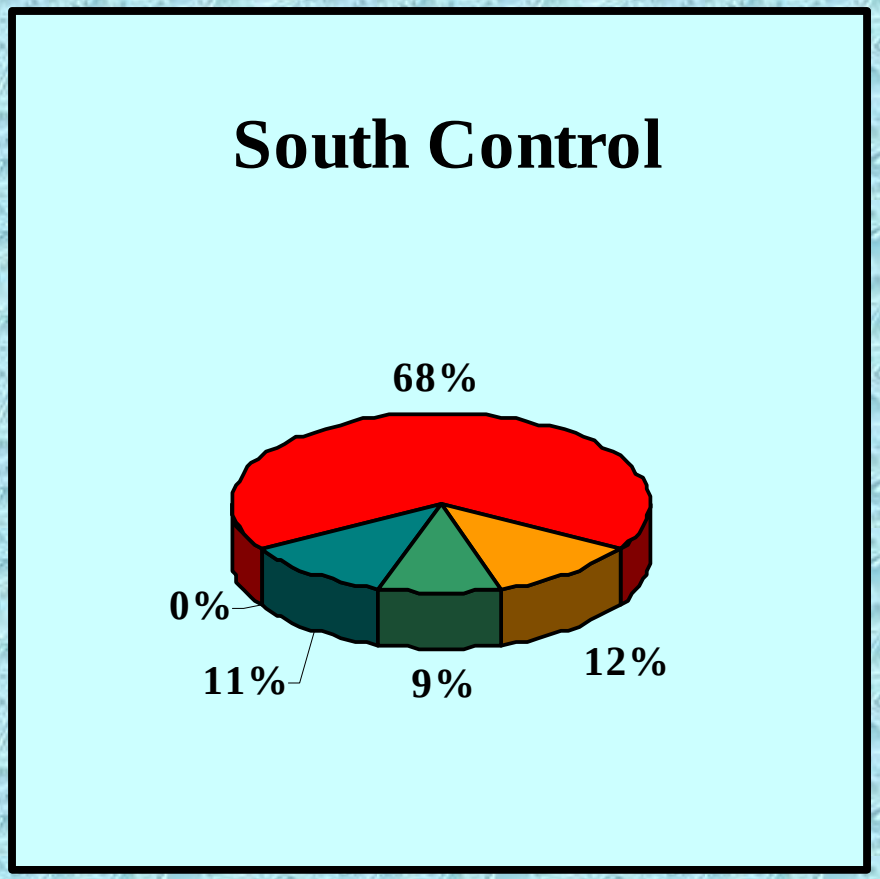
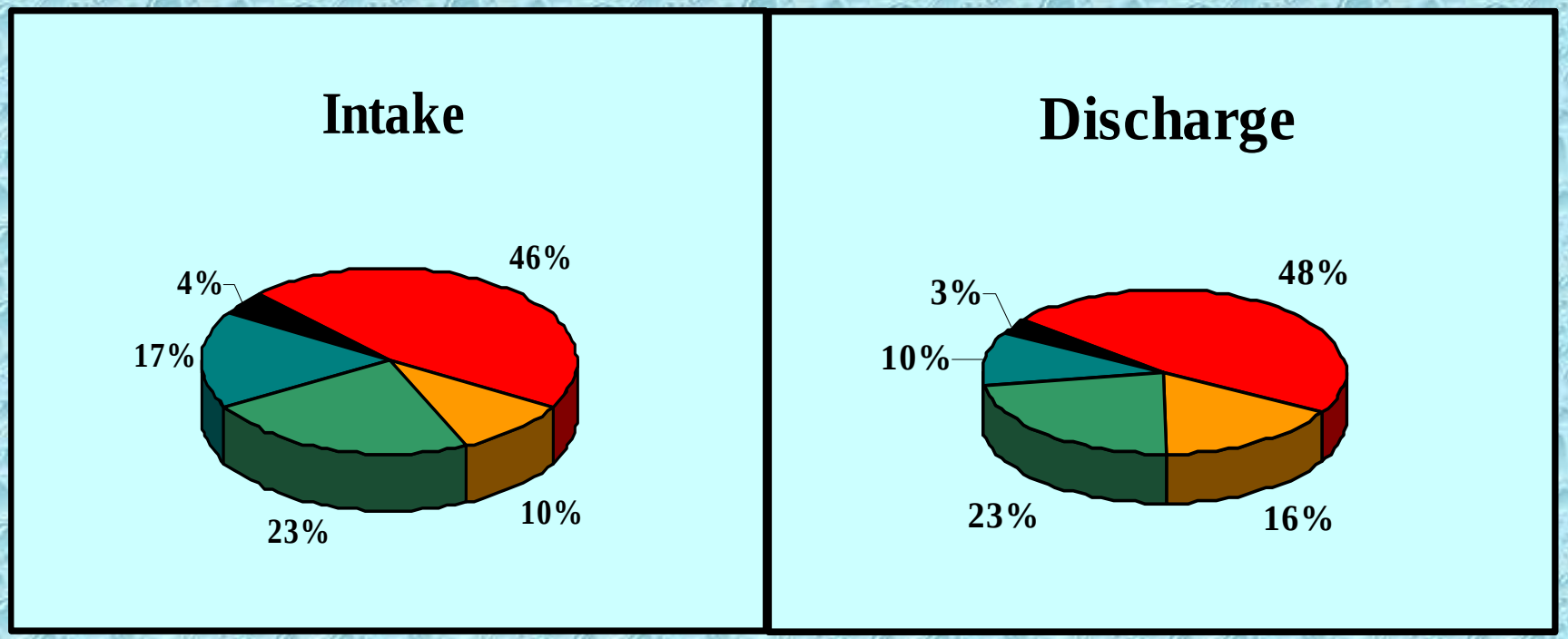




Phytoplankton Composition - March

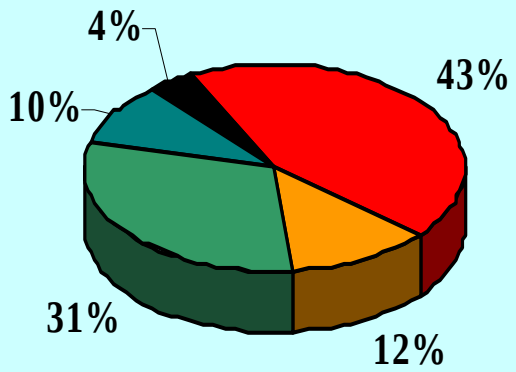
Diatoms, Chlorophytes, Cryptophytes, Cyanobacteria, Dinoflagellates



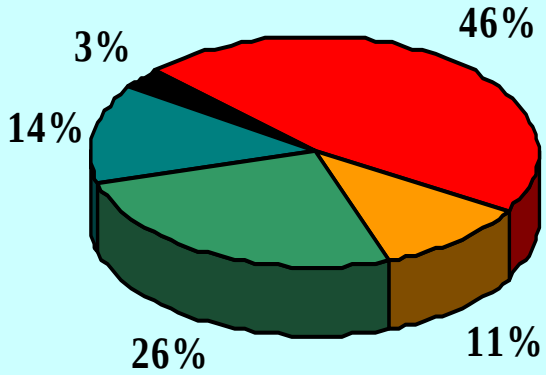
Phytoplankton Composition - March

Diatoms, Chlorophytes, Cryptophytes, Cyanobacteria, Dinoflagellates

Thermal

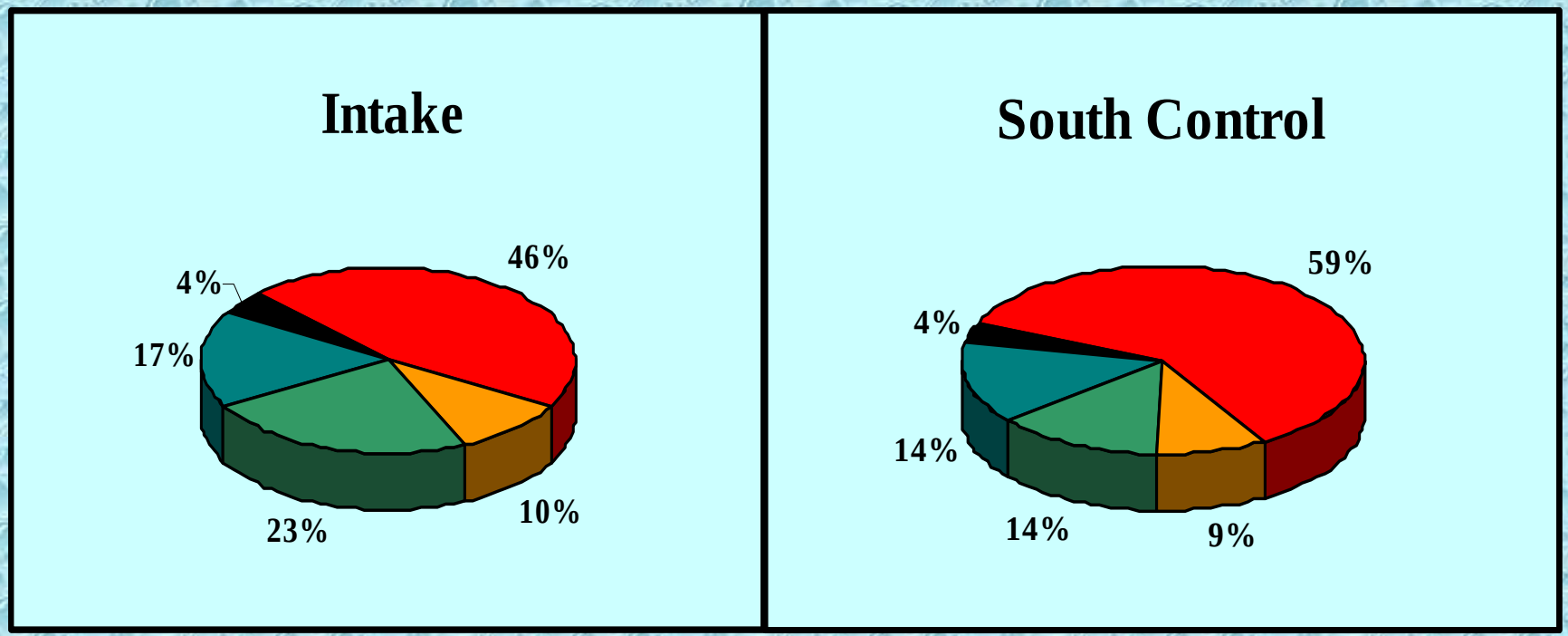


North Apollo Bay

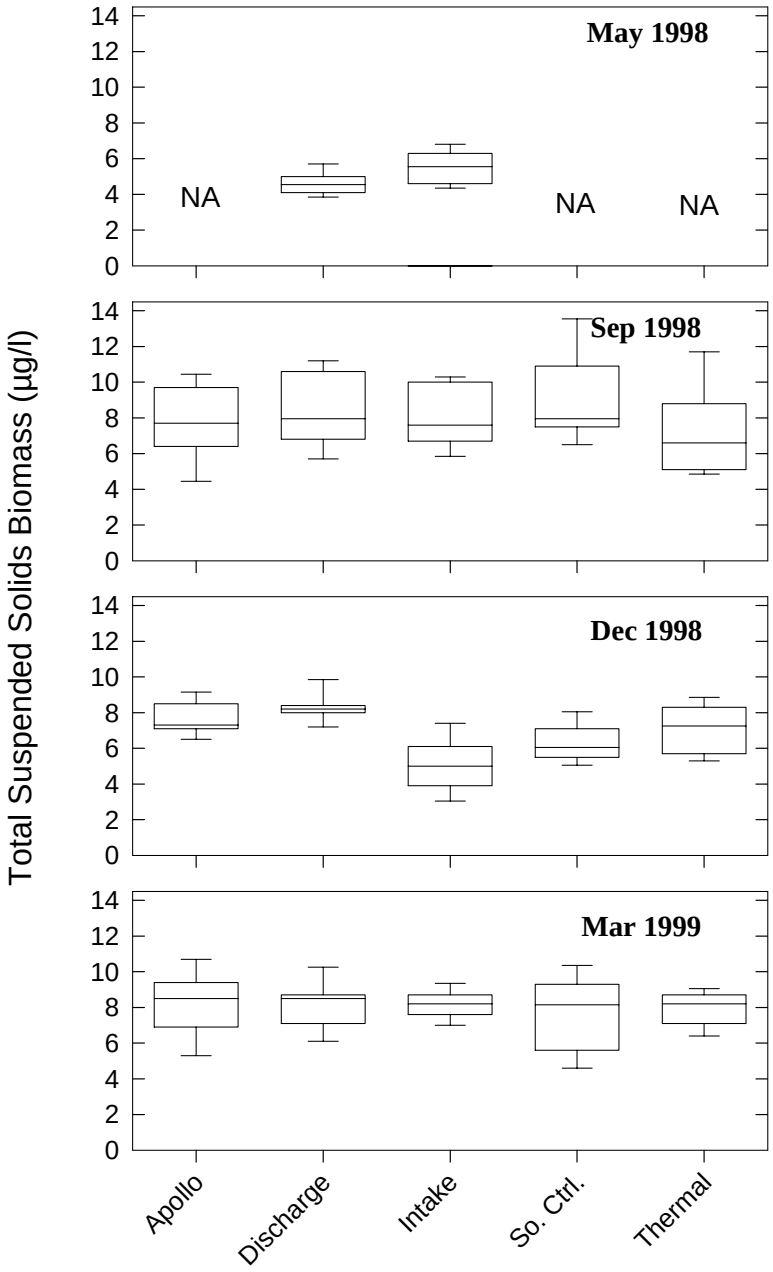


Phytoplankton Composition - March

Diatoms, Chlorophytes, Cryptophytes, Cyanobacteria, Dinoflagellates



Total Suspended Solids – All Months



Summary

Physical Disruption Hypothesis

- Supported by the size distribution data

May
Shift in the percentage of particles in the larger sizes to smaller sizes after passage through the plant.

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Summary - continued

Physical Disruption

September
Large size particle shift was not evident.

May and September
Small size range (10 - 20 um) showed a reduction of particle numbers after plant passage.

Summary - continued

Physical Disruption

December - North Apollo Bay & Thermal Sites

- Elevation of particle size percentages in the 30 to 40 um range.

- Particle size distribution below 20 um were greater than the Intake and South Control.

Summary - continued

Pigments

- Some pigments decreased from intake to discharge,

- Other pigments showed no marked decrease from intake to discharge

Summary - continued

Pigments

May & September

Decrease (30 to 50%) of chlorophyll a, peridinin and fucoxanthin from Intake to the Discharge (dinoflagellates, diatoms, prymnesiophytes and chrysophytes).

- Physical disruption of cells deemed a likely cause of this effect

Summary - continued

Pigments - March

- Elevated green alga pigments at the north Apollo Bay site.

- - Warm water might be supporting this typically warm weather class of phytoplankton during a typical cool water month.

Summary - continued

Pigments – March continued

- Little evidence of physical disruption for green alga .

North Apollo Bay and Thermal sites

- Enriched particle size percentages at 30 to 40 um (diatoms)

- enhanced particle numbers at 5 to 15 um (green algae).

Summary - continued

Pigments – December

- Slight elevation of fucoxanthin and chlorophyll

- Indicating a possible thermal enhancement of diatoms, prymnesiophytes or chrysophytes

Conclusions

- Shifts in phytoplankton communities were not extreme,
- Primary production in the vicinity of the plant was not significantly altered.
- No algal classes that were present at one site were completely eliminated at another.
- A large portion of the phytoplankton population passes through the plant intact.

Conclusions

Warm Months

Intake to Discharge

- **Reduction of phytoplankton by as much as 50%**

Beyond Discharge

- **No reduction evident - indicating rapid recovery**

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Conclusions

Cool Months

- Enhanced growth of some components of the phytoplankton community by 50 to 400% over the control site.

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Conclusions

Nutrients

- Nutrient availability cannot be ruled out as a contributing factor to this enhanced growth within north Apollo Bay

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Pine Island

Florida Keys