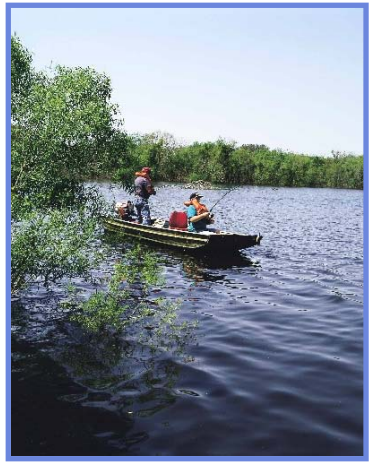
HYDROLOGICS

Advancing the management of water resources



Using Forecasted Inflow to Address RPM 3

Daniel P. Sheer, Ph.D., P.E.

Megan W. Rivera, Ph.D.

Drought Provision Workshop on the Jim Woodruff Interim Operations Plan
13 December 2006

HydroLogics, Inc. Office Locations

10440 Shaker Dr., Ste. 104
Columbia, MD 21046
410-715-0557

811 Mordecai Dr., Ste. 200
Raleigh, NC 27604
919-856-1288

Objectives

- Introduce forecasting methods
- Give an example of using forecasts to implement RPM 3
- Demonstrate the potential benefits of forecasts in alternative operations

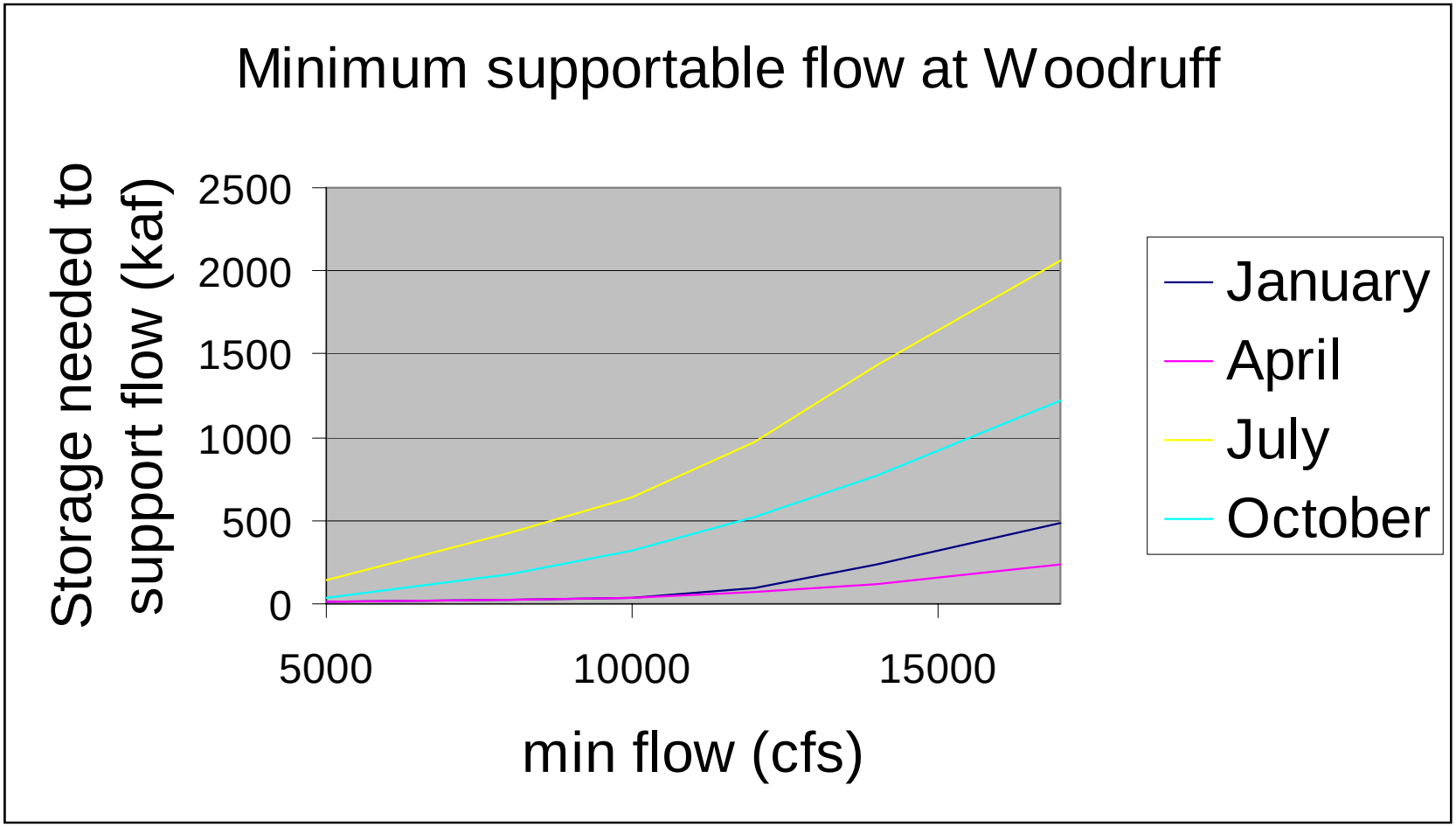
Mid Range Forecasting Techniques

- Monthly serial correlation--Hirsch
- NWSRFS—Sacramento SMAM
- These techniques do not rely on weather forecasts, only basin conditions
- Both produce information about shift in expected mean and variance of future inflows

Provide highest minimum flow possible while refilling system by 6/1

- WWR(flow) = Water required to maintain the flow at Woodruff$^{90\%}$
- Water available = forecasted inflows$^{90\%}$ - demands - IFrequirements - evap - void
- WWR(flow) = Water available

WWR(flow) using 90th percentile of historic inflows



Calculating WWR(flow)

- For a range of flows:
  - Calculate difference between the desired flow and historic BI each day— this gives water needed from storage each day, if any
  - Sum needed flows between now and June 1 to get required storage

Determine Water Available and Maximum Supportable Flow

- Forecast inflow to Lanier between now and June 1
  - Lanier used as a surrogate for system storage—when Lanier is full, the system is full
  - Currently, using 90th percentile of forecasts
- Subtract out volume needed for metro min flow requirement, local demands, evap, and refill
- Use graph to determine maximum supportable flow

HYDROLOGICS

What can forecasts achieve?

- A demonstration of alternative methodology …
- This has not been refined: we're sharing an approach, not proposing a specific solution
- So we can compare apples to apples, the following are the same as the IOP in BiOp (IOP_23K_70_2RI)
  - 2000 demands
  - Min Flows:
    - Atlanta = 750 CFS;
    - Columbus = 1,850 CFS when WP > 621.6',
      1,200 CFS when WP < 621.6'
  - Reservoir conservation pool rules
  - Ramping rates for mussels

HYDROLOGICS

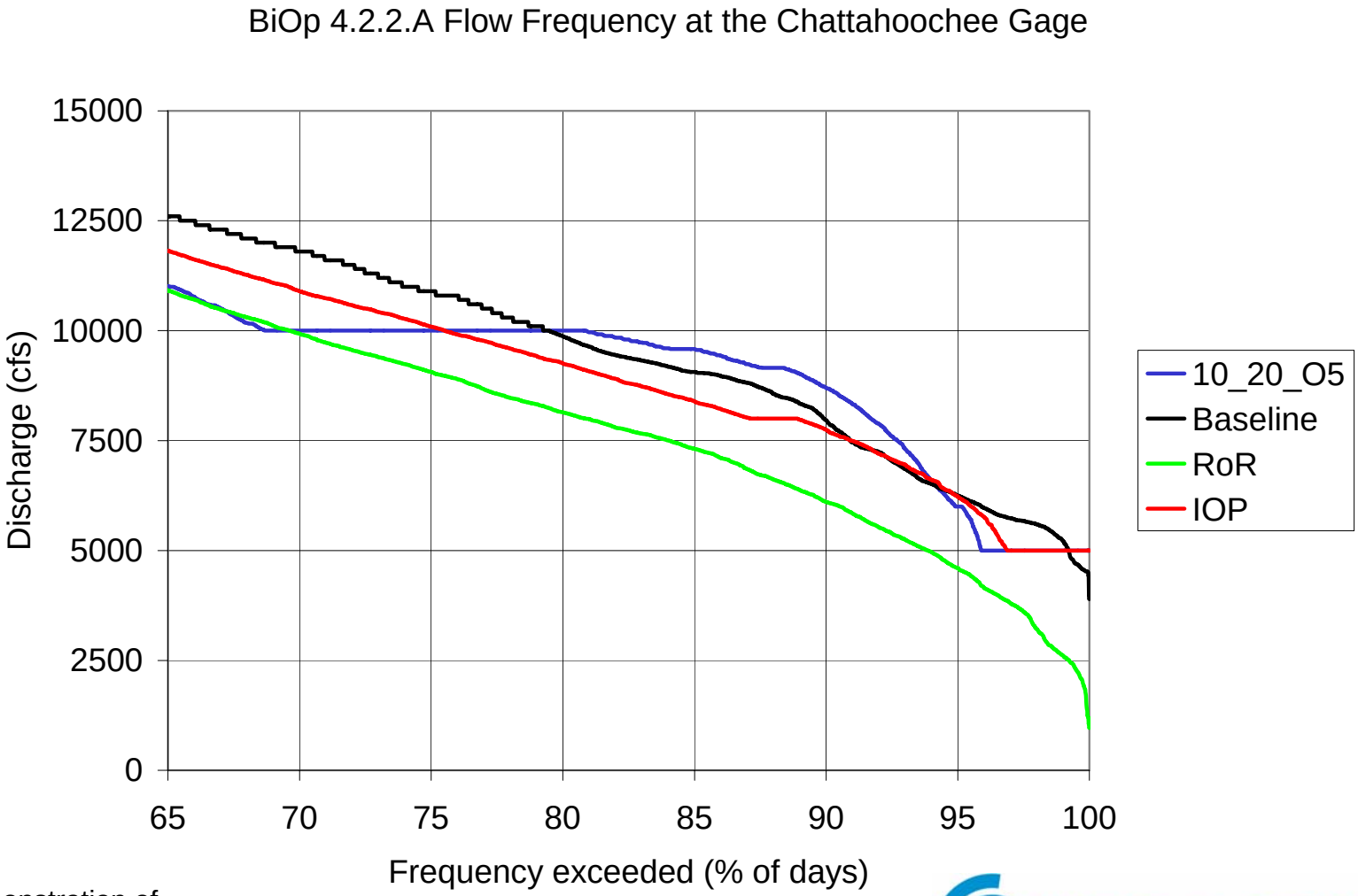
Evaluation

- BiOp figures
- Additional measure of sustained low flows
- Reservoir storage
  - Recreational impact
  - Preserve water for future droughts
- This is not a full evaluation, additional performance measures are needed

Summary of Results: the demo run compared to IOP

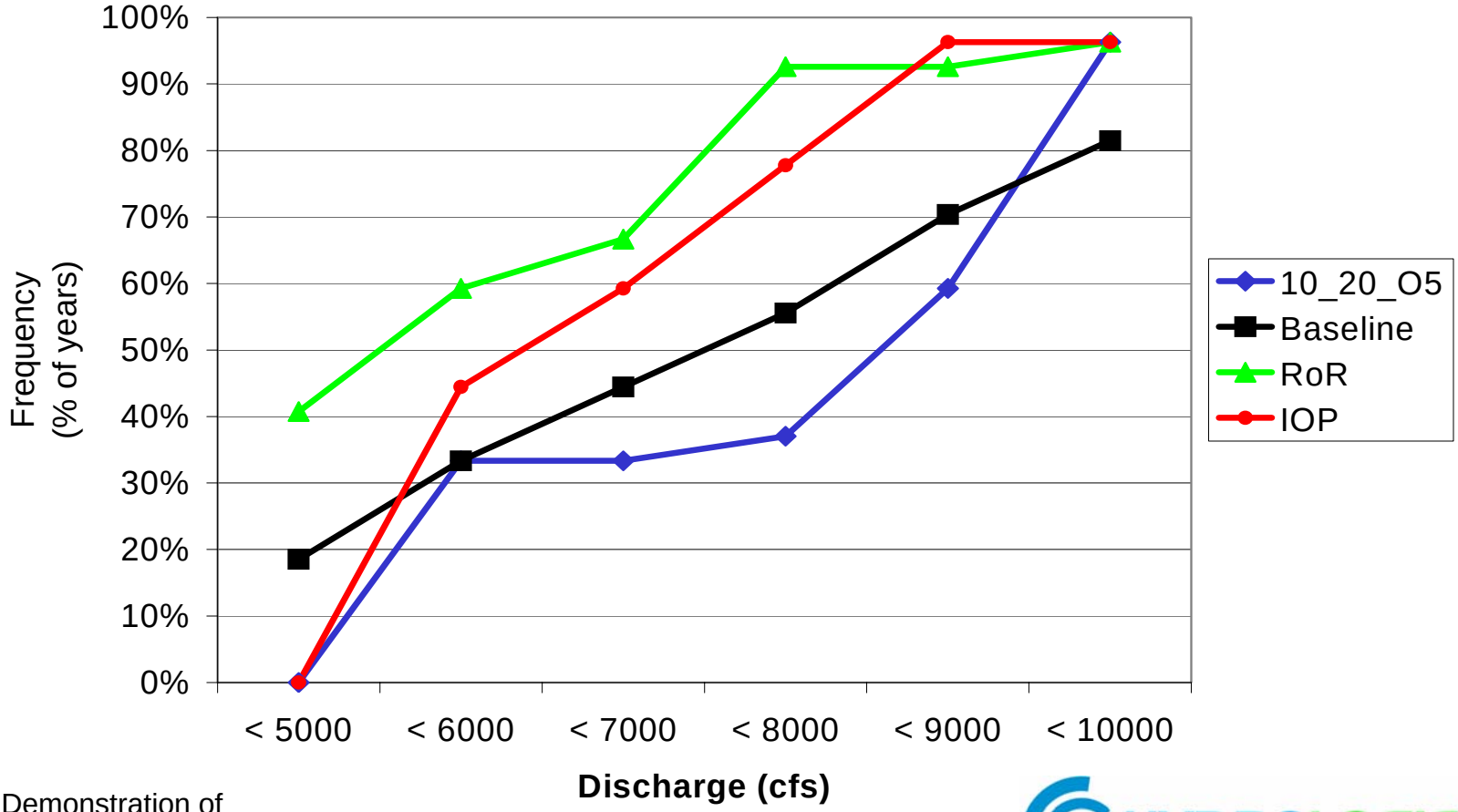
- Significantly better for mussels
  - Higher flows for longer periods of time in 5 – 10k cfs range
- More water in system storage/less recreation impact
- Arguably better sturgeon habitat
- Comparable floodplain connectivity

Higher flows in critical range for mussels



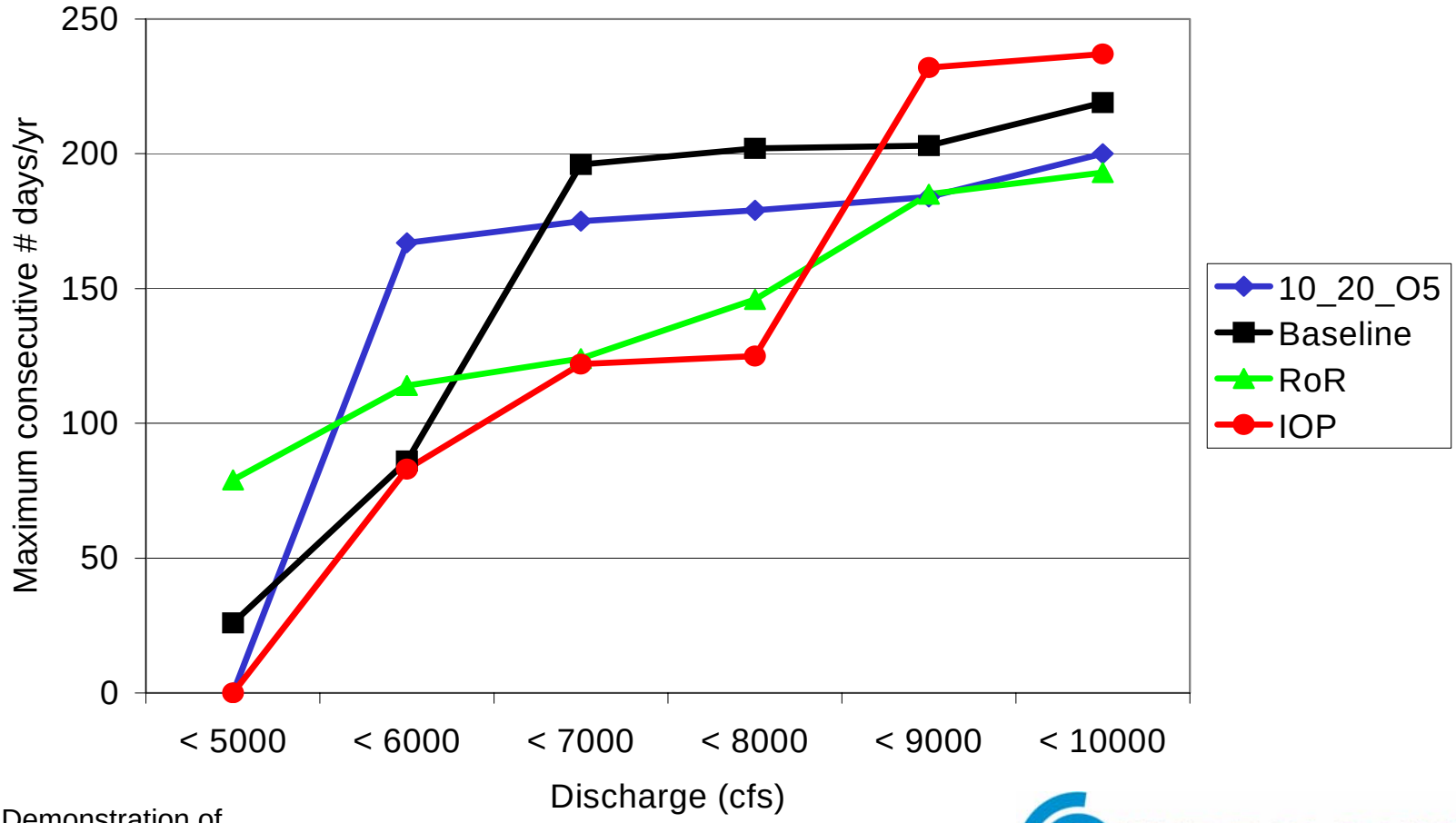
Fewer years with low flows

Figure 4.2.5.A



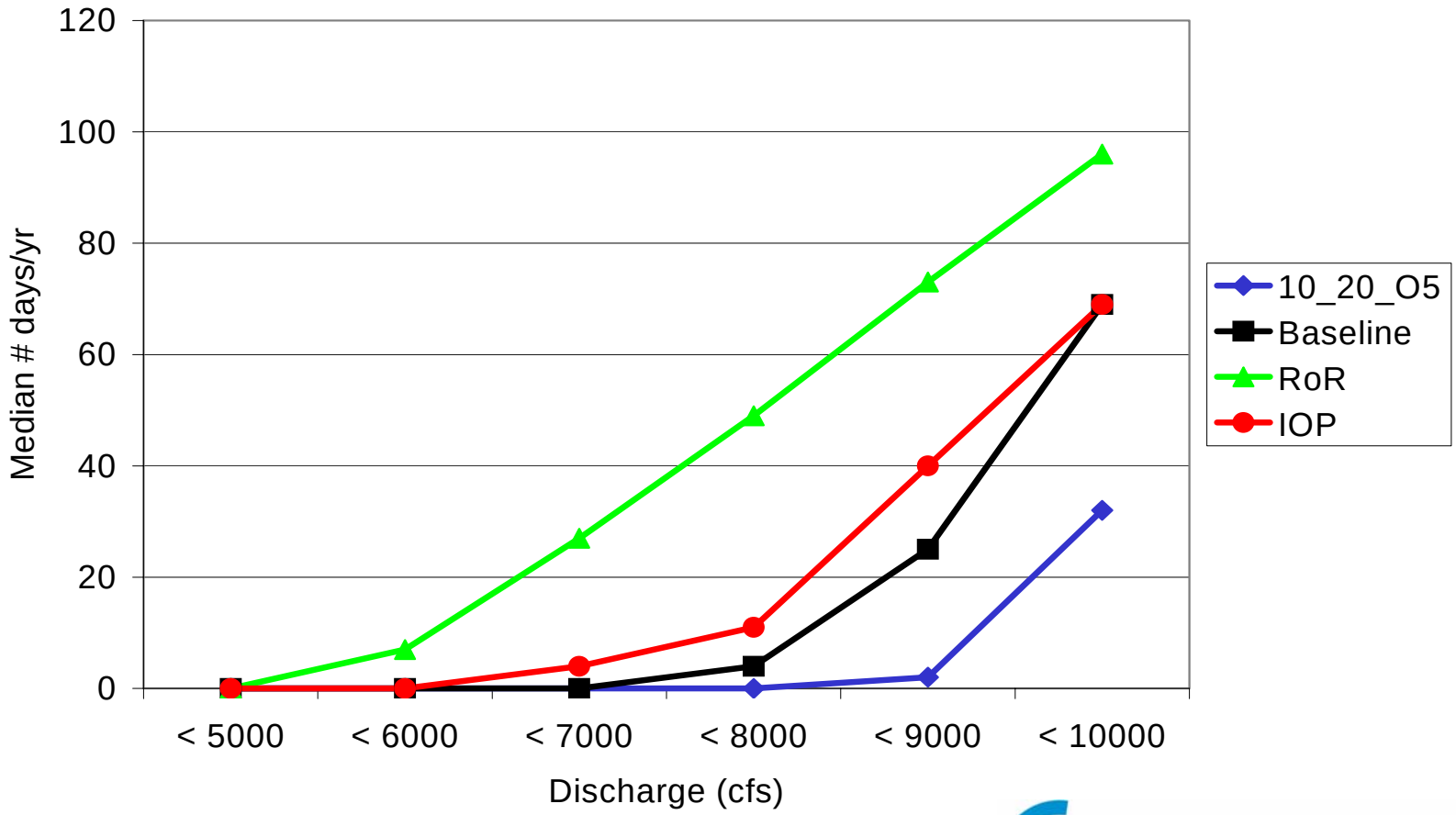
More consecutive days of low flow in worst year: Consistent with RPM3

Figure 4.2.5.C

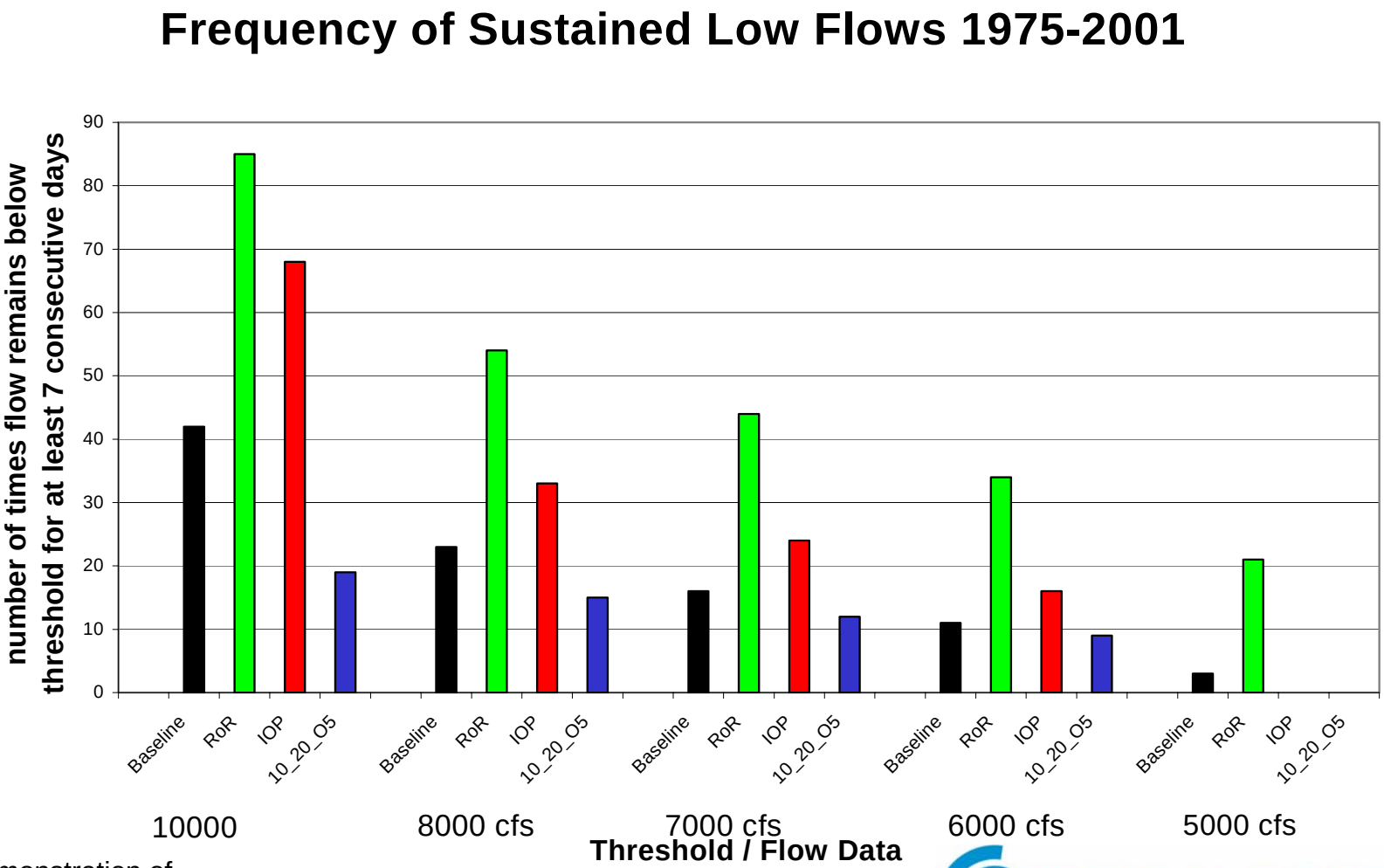


Fewer consecutive days of low flow in general: Consistent with RPM3

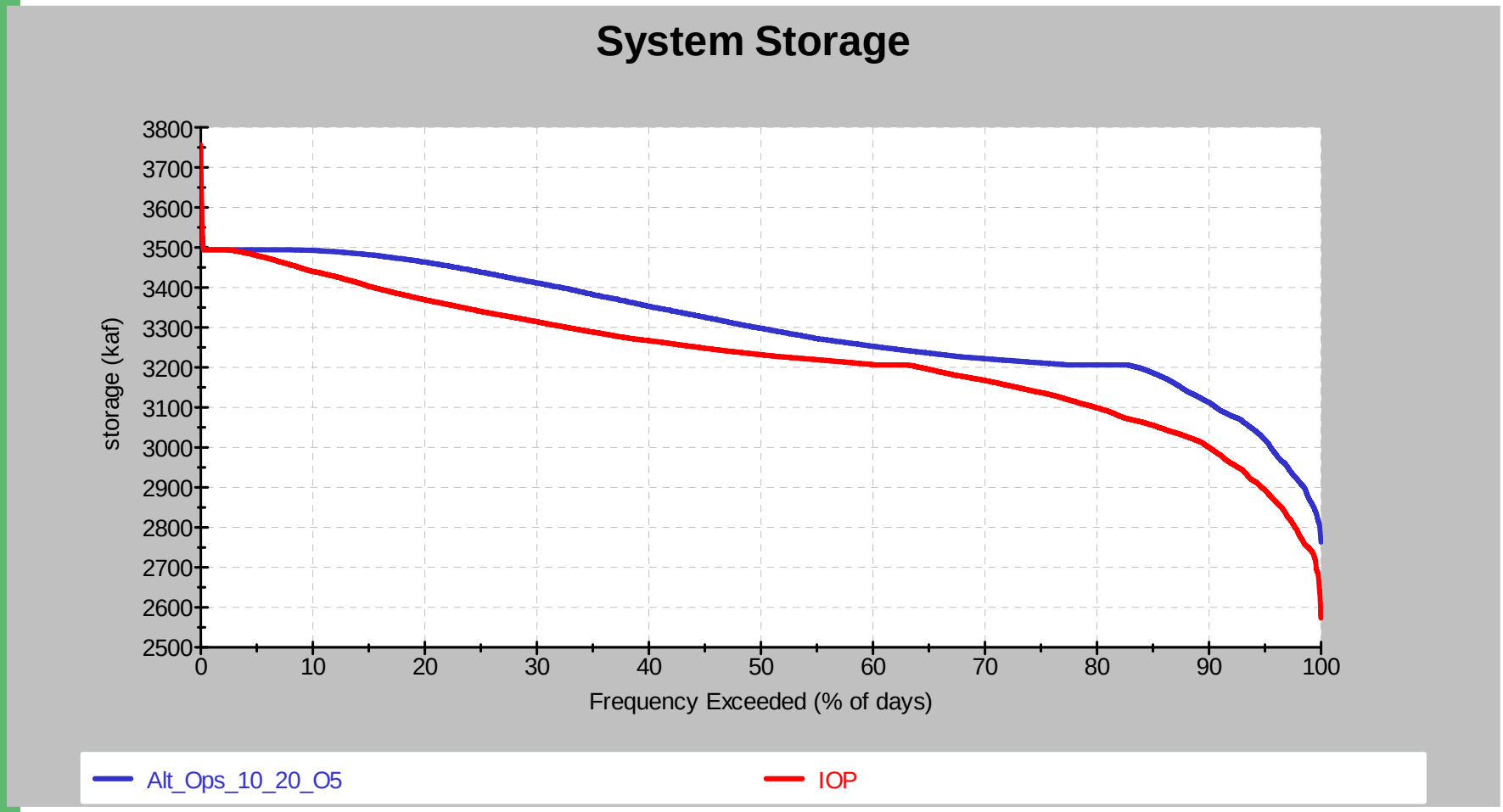
Figure 4.2.5.D



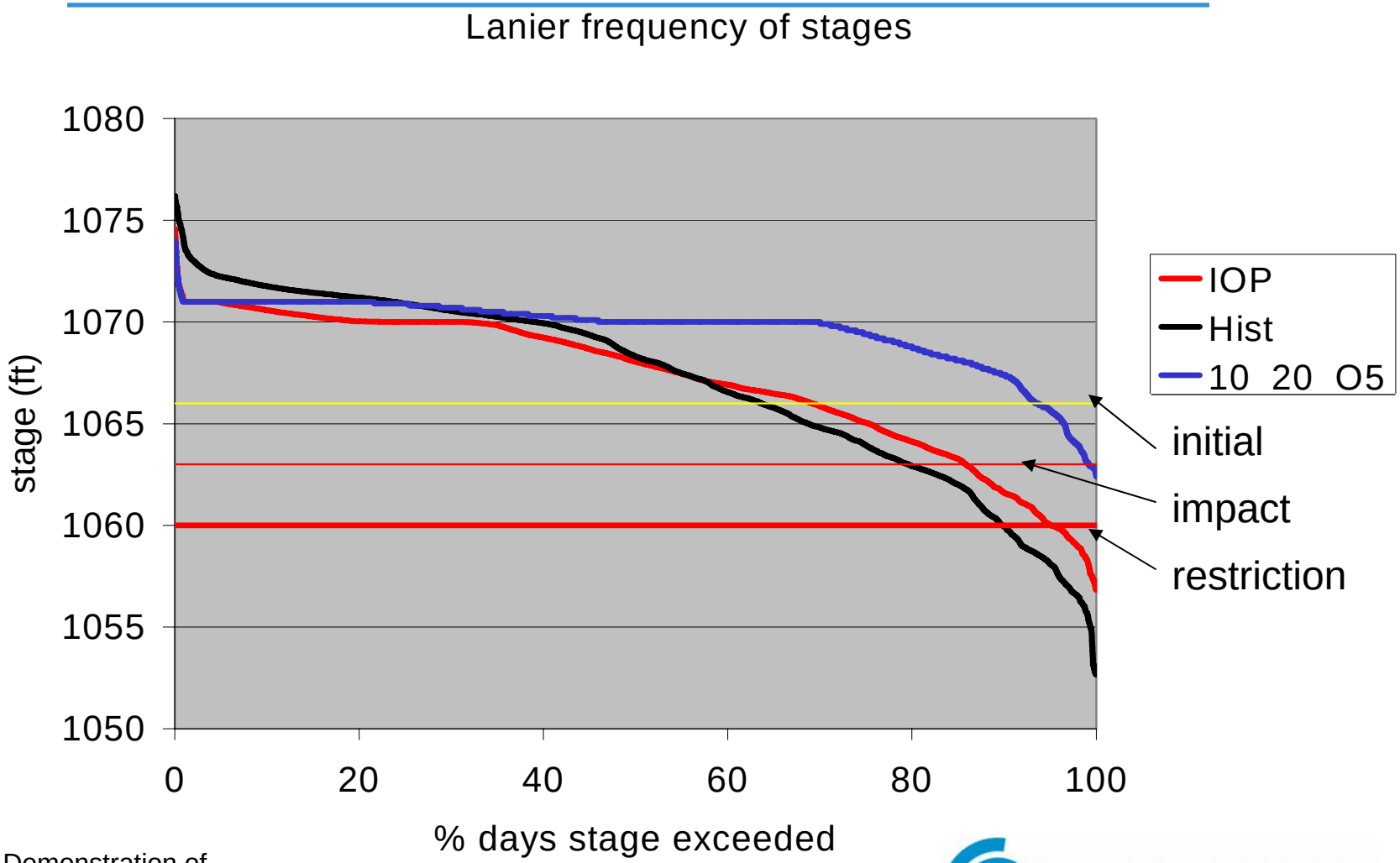
Fewer occurrences of sustained low flows



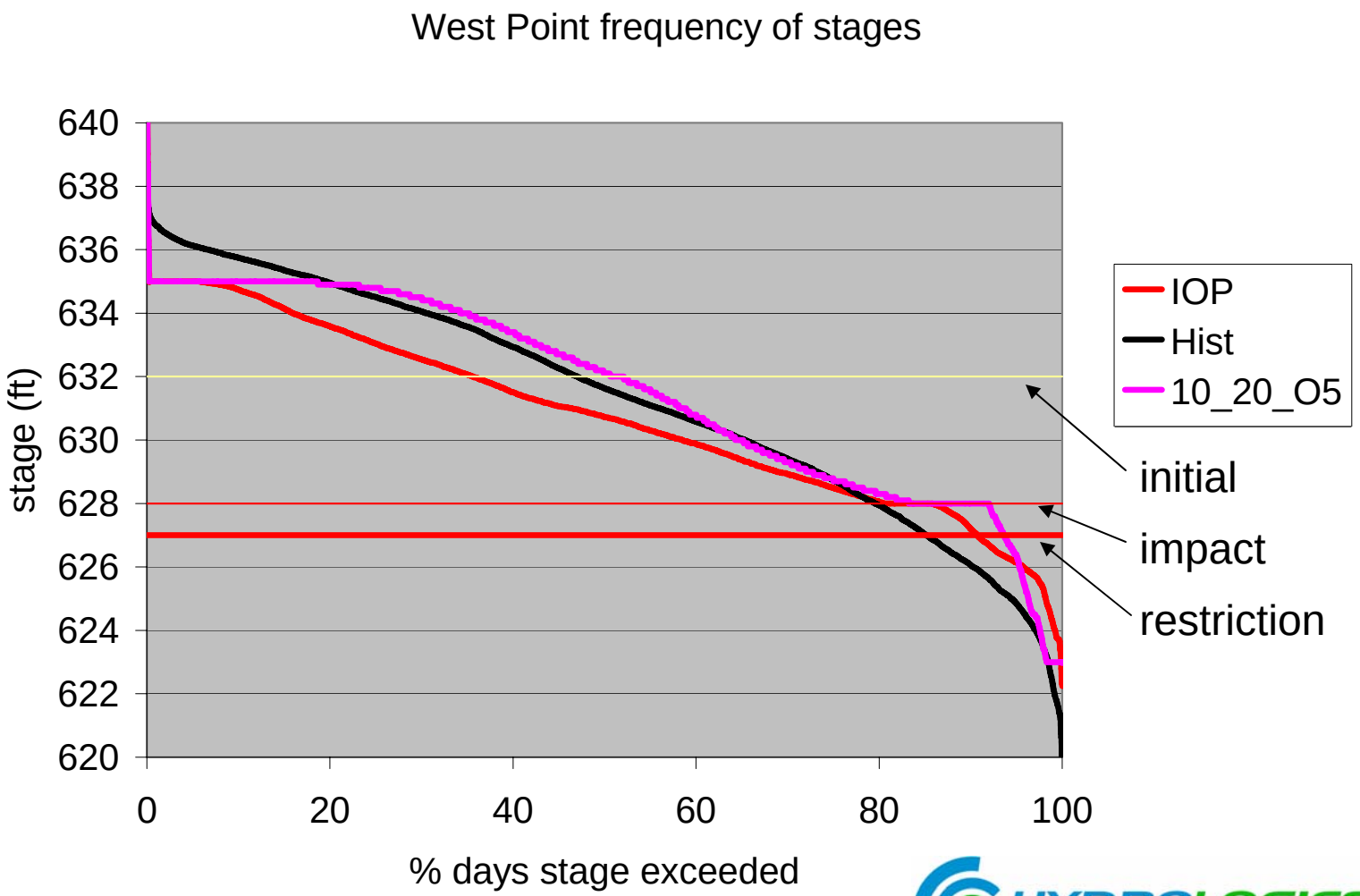
More water in system storage



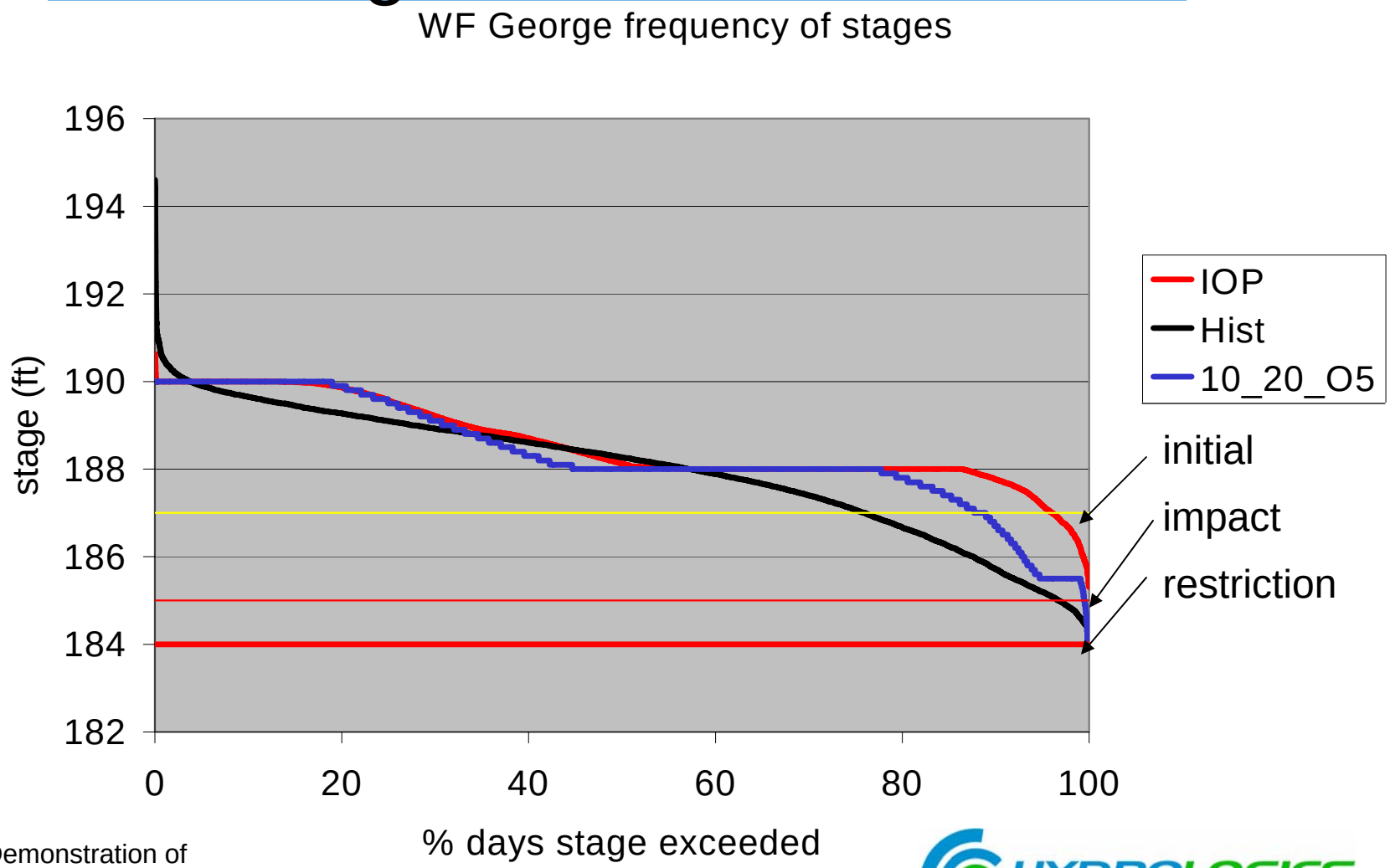
More water in Lanier



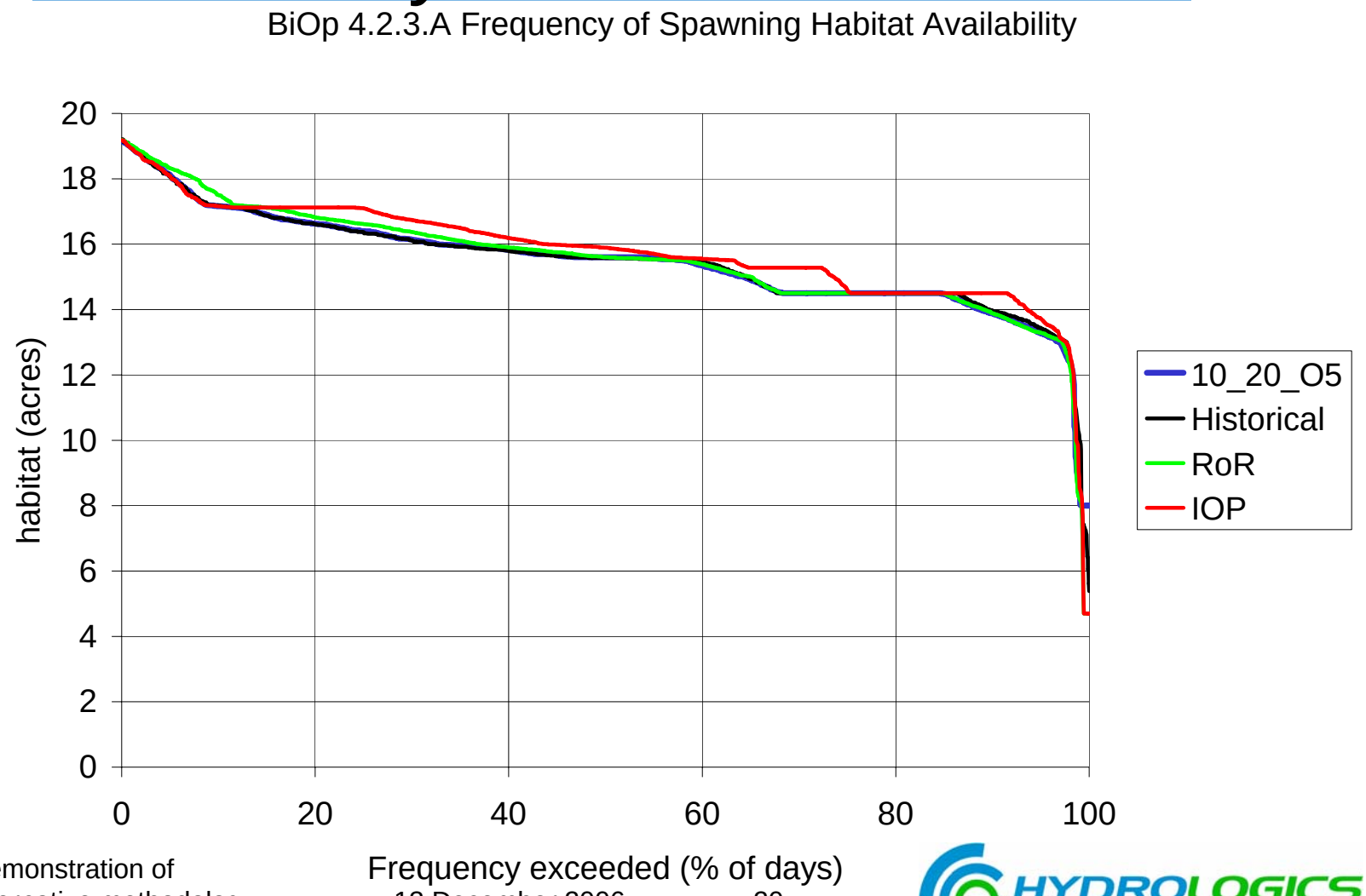
Slightly more water in West Point



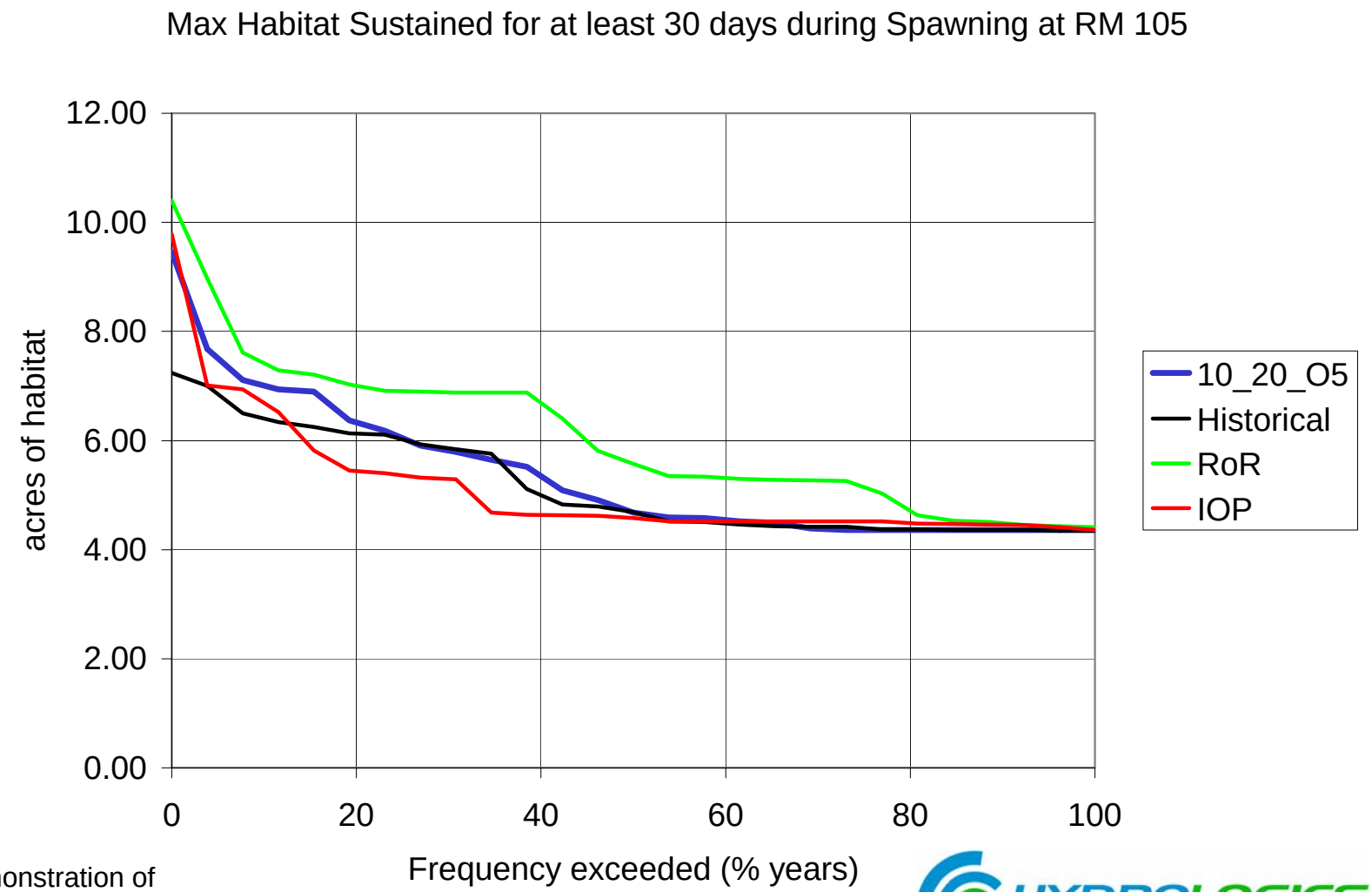
Still more water than historical in WF George



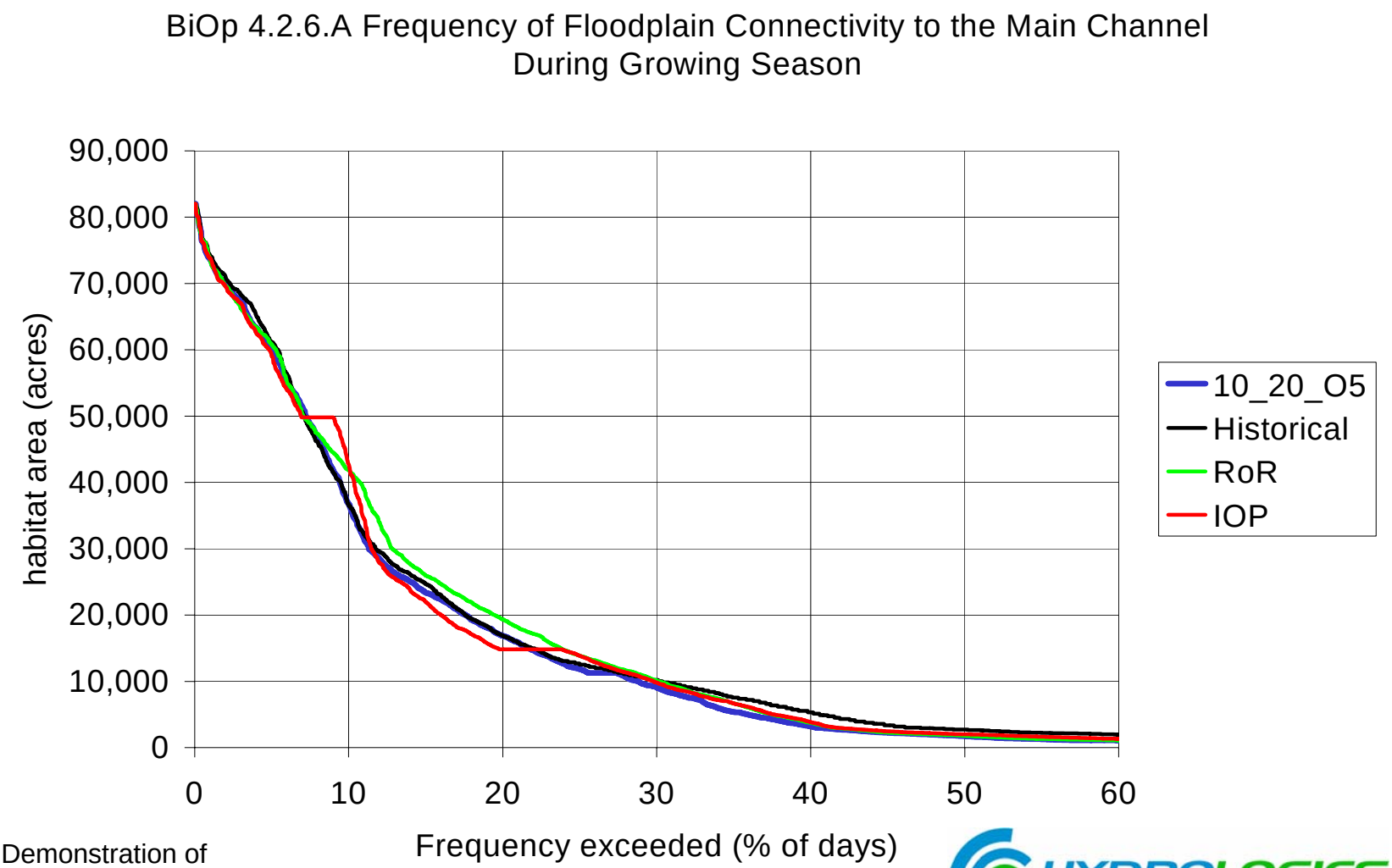
Little Reduction of Total Sturgeon Habitat Days



Increase in sustained sturgeon habitat at RM 105



Comparable Floodplain Connectivity



What else is in the demo run?

- Protect public health and safety
- Preserve and enhance endangered species
  - *Preserving* endangered species
    - In demo run:
      - Mussels: 5000 cfs min and ramping rates as defined in IOP
      - Sturgeon: 6000 cfs min flow during spawning season
    - Sufficient storage must be reserved to meet these requirements in droughts
  - *Enhancing* endangered species
    - In demo run: <u>provide the highest maintainable minimum flow</u>
    - Balanced with other project purposes
- Other project purposes
  - Project authorizations are interpreted by the USACE to determine relative priorities and balancing of benefits

HYDROLOGICS

Protect Public Health and Safety

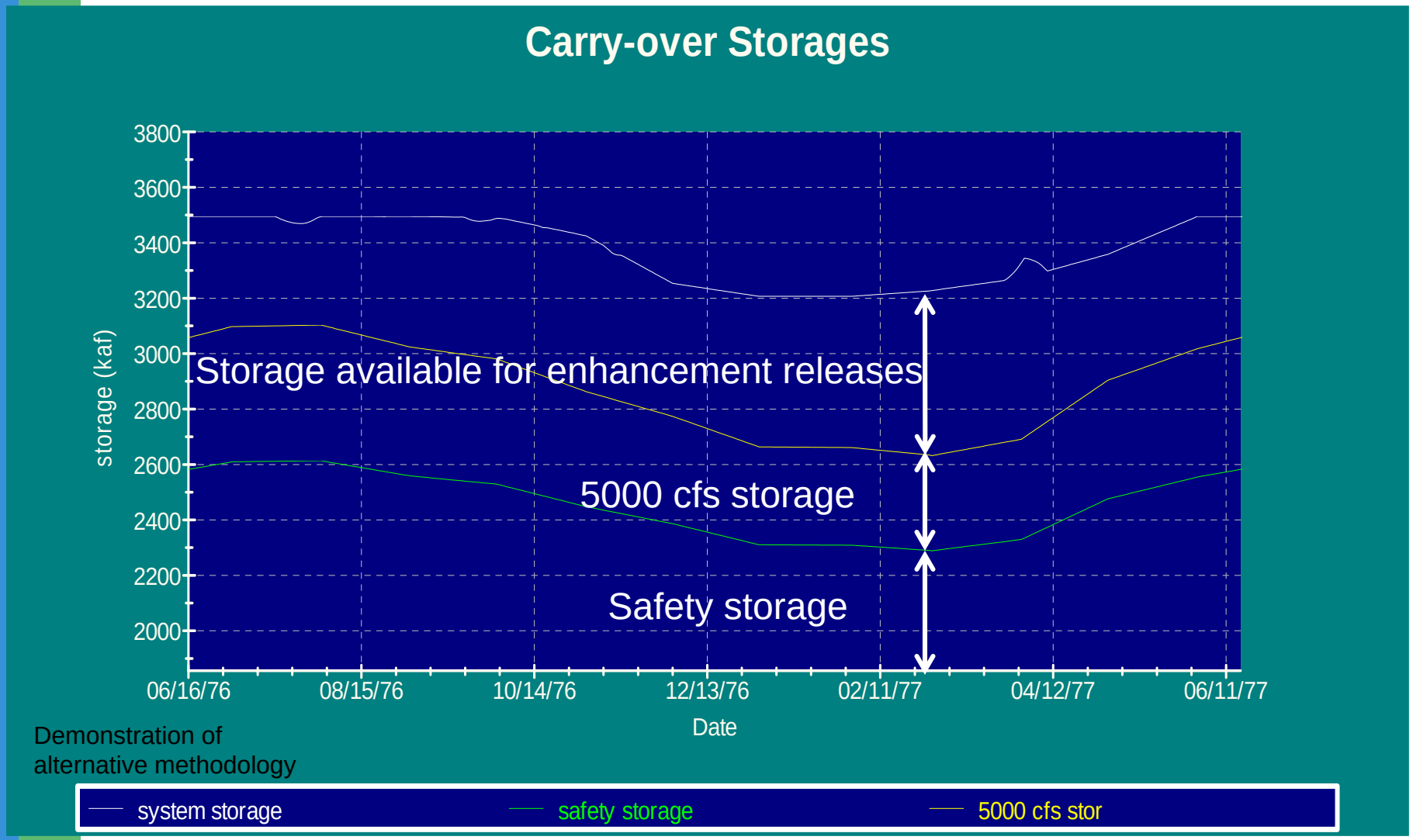
- Reserve enough water to meet public health and safety requirements
  - Maximum system drawdown over a multi-year period to meet 2030 demands and minimum instream flows plus a margin of safety
  - Determined by model runs

HYDROLOGICS

Protect Endangered Species

- Reserve enough water to maintain 5000 cfs and respect ramping rates over a multi-year period

Safety and 5000 cfs carry-over storages



Demonstration of alternative methodology

Releases made below Woodruff

System storage > full	Releases needed to maintain flood protection
System storage > 5000 cfs carry-over	Enhancement releases = max supportable flow
System storage > safety storage	5000 cfs
System storage < safety storage	No requirement
Storage available for enhancement releases is managed to avoid the last two cases for the entire historical record	

HYDROLOGICS

Managing storage available for enhancement

- Maintain maximum supportable flow, but no more than 10,000 cfs
- Rationale
  - No apparent value to mussels
  - Increase in sturgeon spawning habitat levels off at 10,000 cfs
- Effect on spawning habitat shown on the next slides

Relationship between habitat and flow

Biological Opinion for Woodruff Dam Interim Operations Plan September 5, 2006

Habitat (acres)

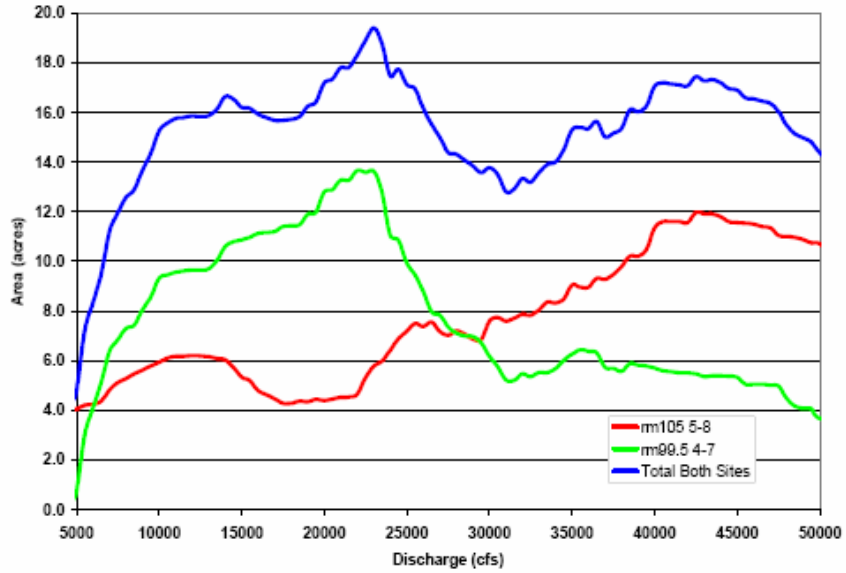
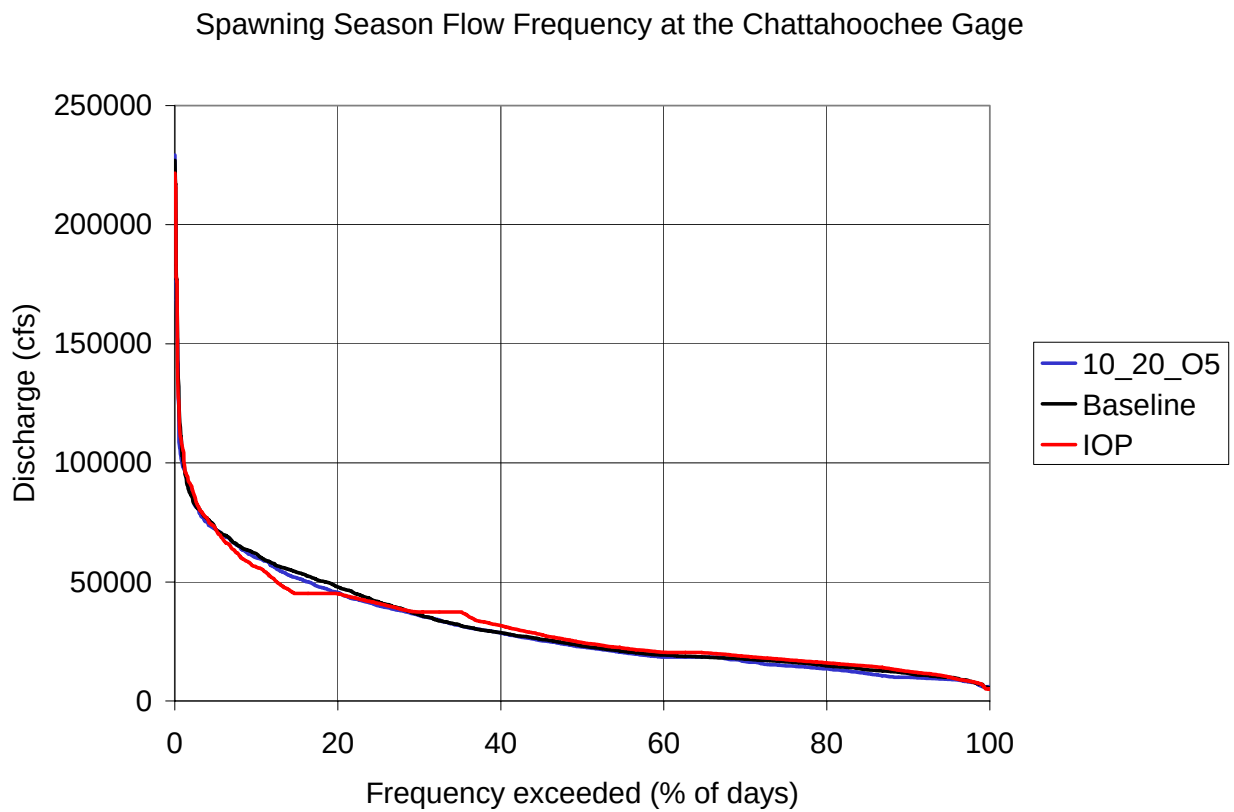


Figure 3.6.1.4.C. Area (acres) of hard substrate inundated to depths of 8.5 to 17.8 ft deep at the two known Gulf sturgeon spawning sites on the Apalachicola River (RM 105 and RM 99) at flows of 5,000 to 50,000 cfs, based on the cross sections located closest to egg collections during 2005 and 2006.

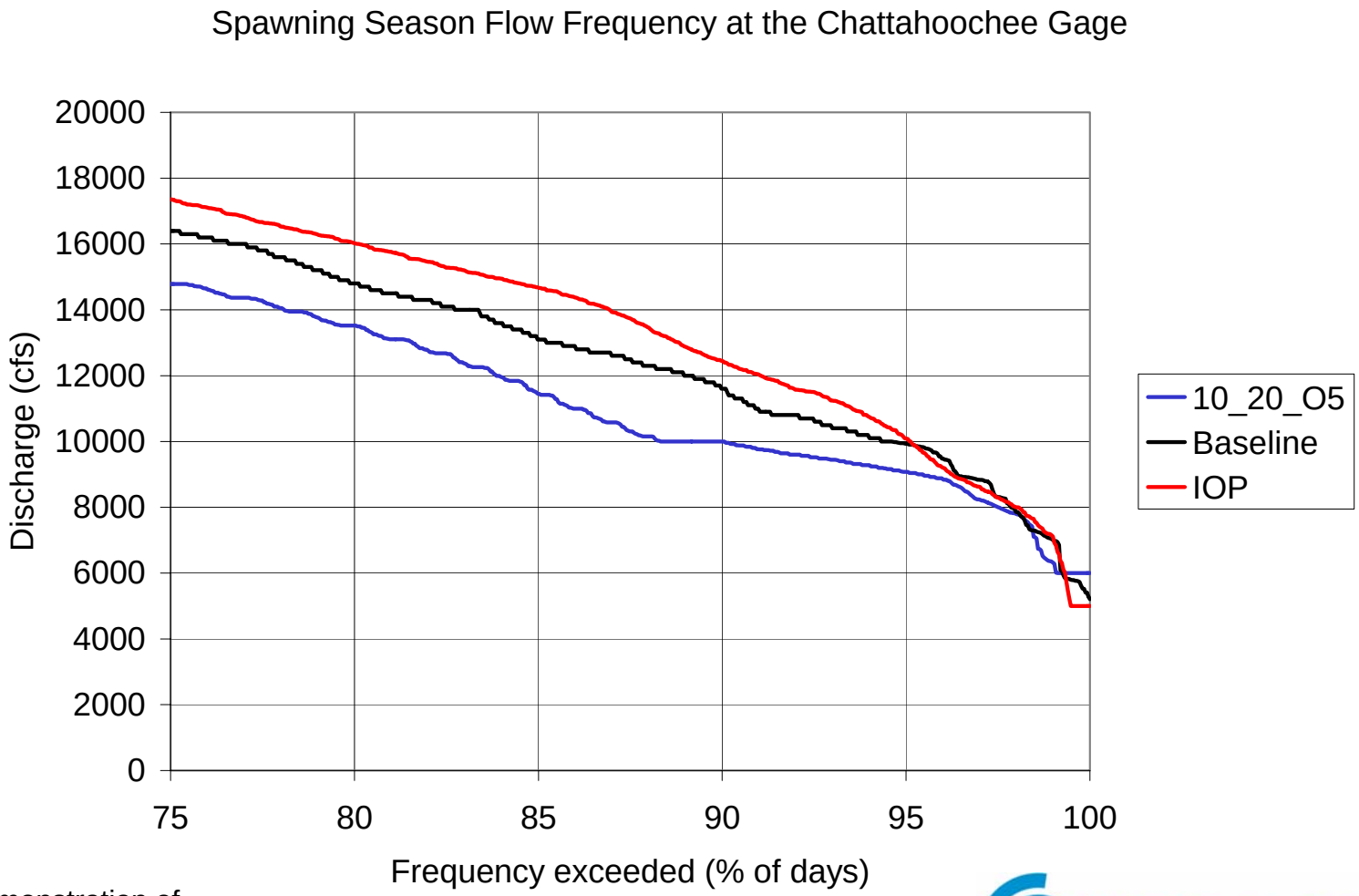
Flow (cfs)

HYDROLOGICS

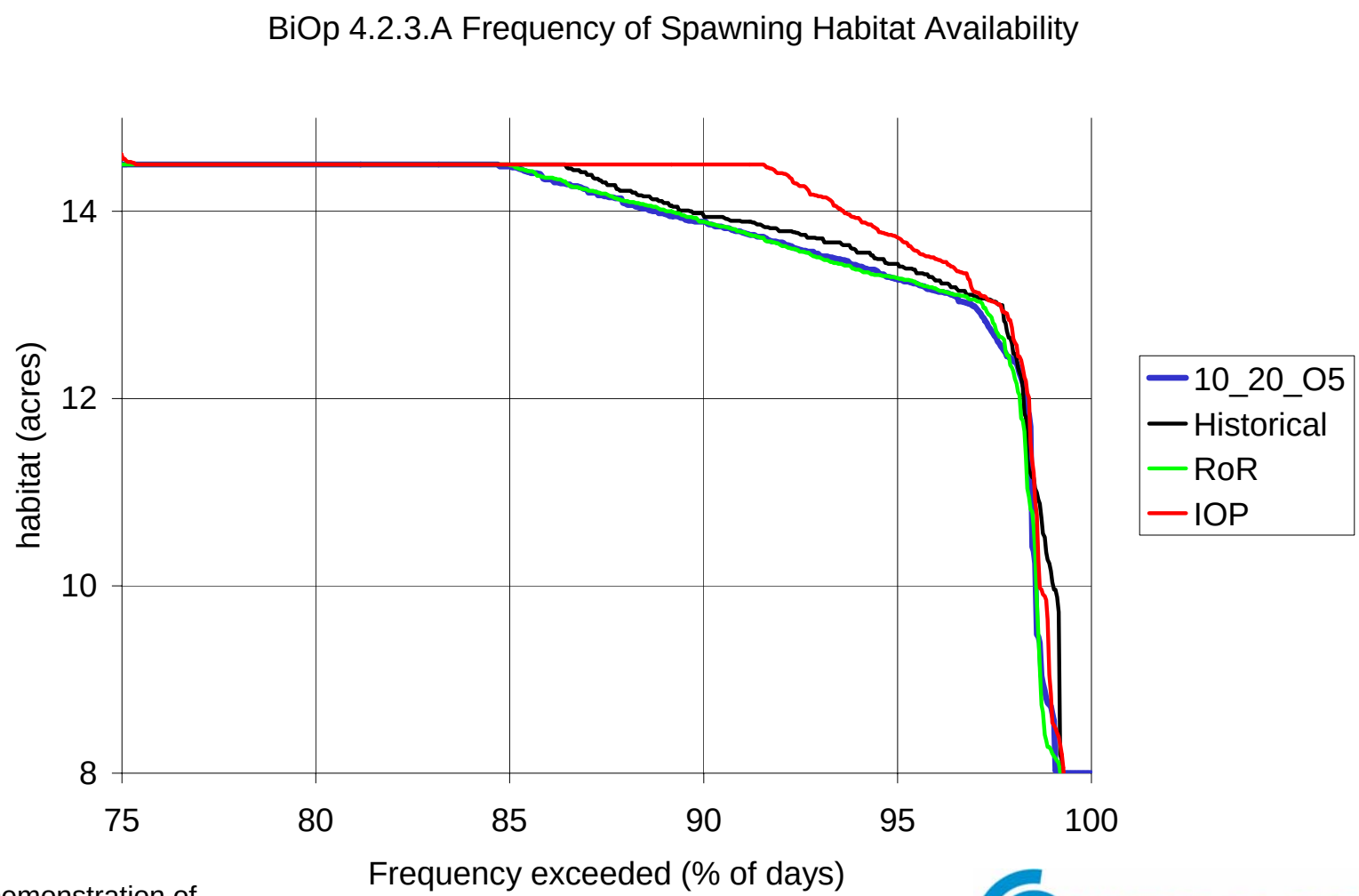
Overall Spawning Season Flows are close to historical and IOP



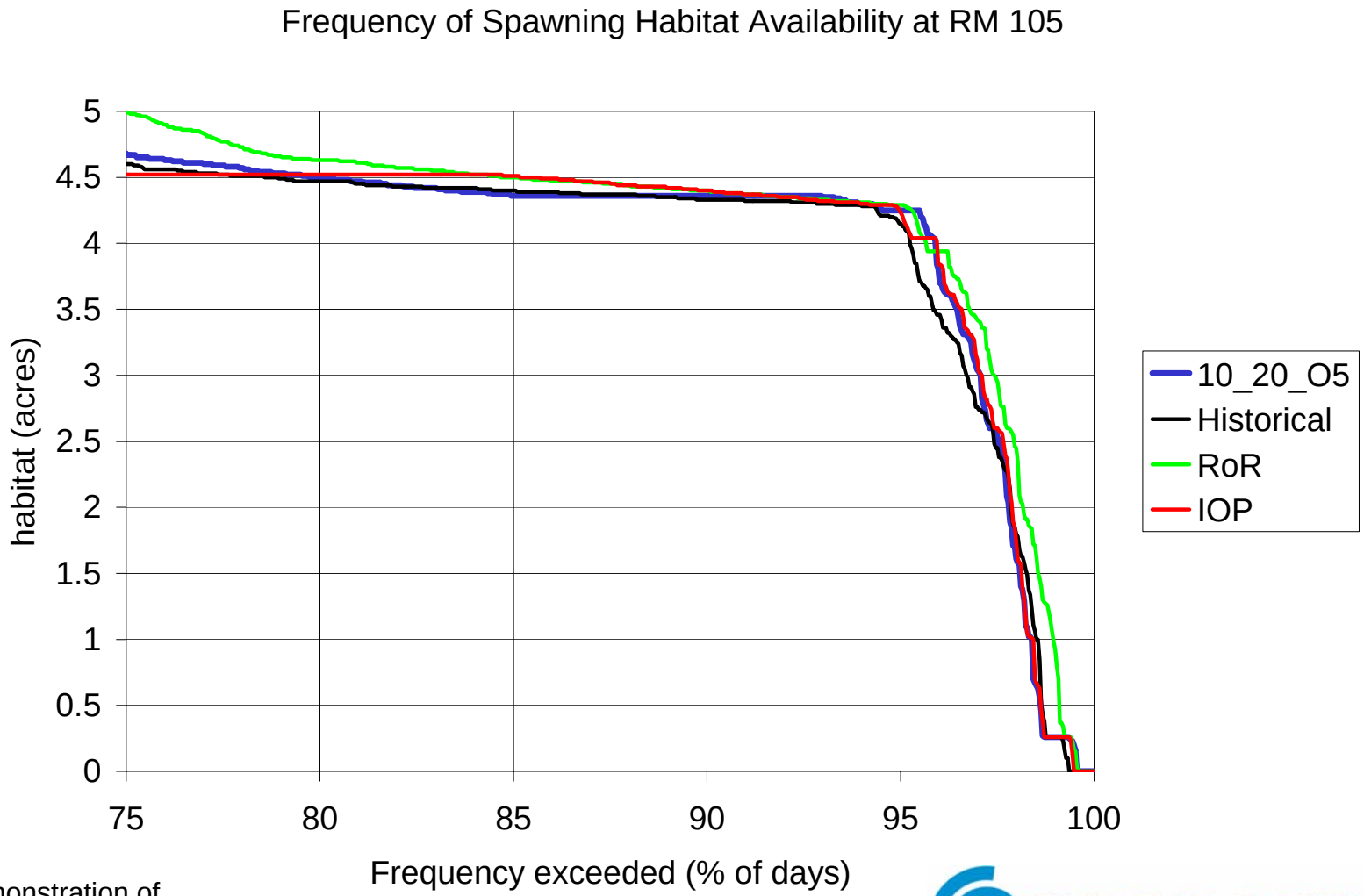
Infrequent flows are lower, but …



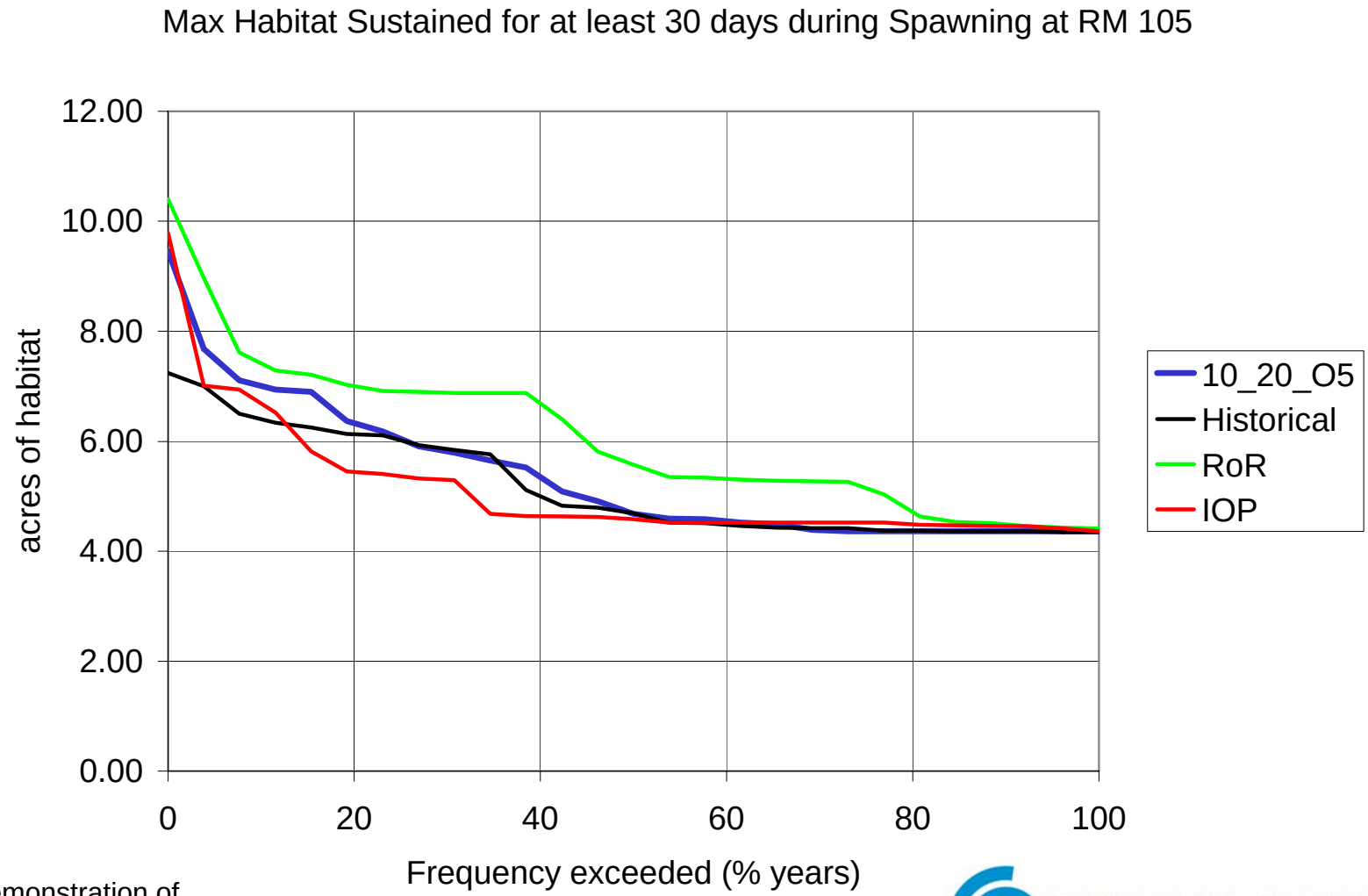
… the difference in **total** habitat is small



… the difference in habitat at **RM 105** is even smaller



… and there is more sustained habitat at **RM 105**



This is because of the relationship between habitat and flow

Biological Opinion for Woodruff Dam Interim Operations Plan September 5, 2006

Habitat (acres)

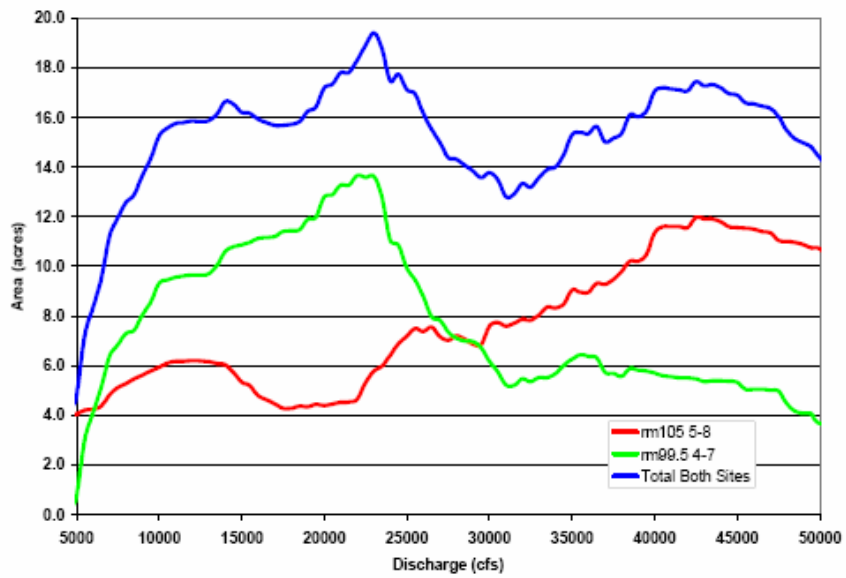


Figure 3.6.1.4.C. Area (acres) of hard substrate inundated to depths of 8.5 to 17.8 ft deep at the two known Gulf sturgeon spawning sites on the Apalachicola River (RM 105 and RM 99) at flows of 5,000 to 50,000 cfs, based on the cross sections located closest to egg collections during 2005 and 2006.

Flow (cfs)

HYDROLOGICS

Results can be counter-intuitive

- The sturgeon habitat results highlight the importance of evaluating operations based on ***performance*** rather than volumes of water
- A full range of ***performance measures*** is needed

Conclusion

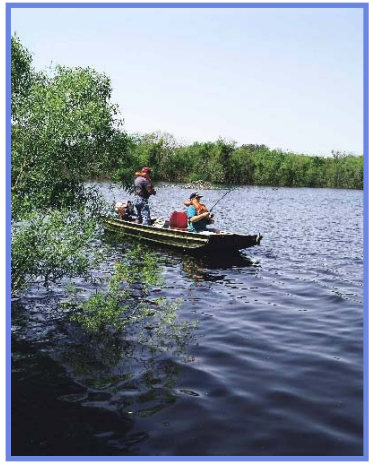
- Using forecasted inflows in conjunction with current storage to implement RPM 3 can identify the largest minimum flow that will not compromise next year's flows.
- Implementing RPM 3 in a manner similar to the implementation in the demo run will provide significantly more benefits to all users.
- The operating rule used in the demo run can be further improved
  - Consider other performance measures
  - Consider other factors in determining Woodruff releases
  - Reservoir balancing
  - Optimize parameters

HYDROLOGICS

HYDROLOGICS

Advancing the management of water resources

Thank You!



HydroLogics, Inc.
Office Locations

10440 Shaker Dr., Ste. 104
Columbia, MD 21046
410-715-0557

811 Mordecai Dr., Ste. 200
Raleigh, NC 27604
919-856-1288