Gaming to Study
Flexing The X2 Standard

SWRCB Workshop on Flexing

August 31, 2005

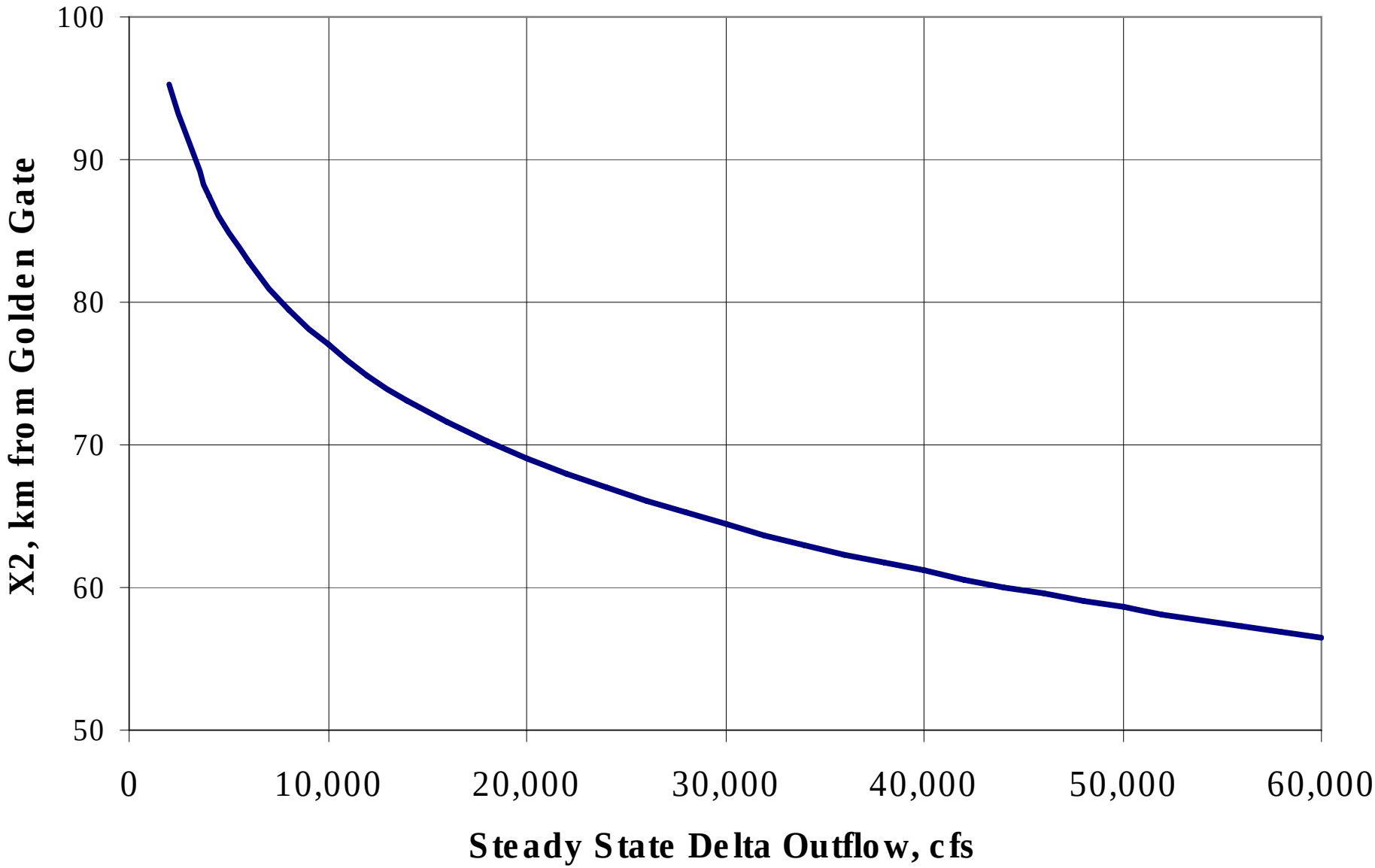
Outline of Presentation

- Why game?
- Who participated in various games?
- What was gamed?
- How was gaming conducted?
- Goals
- Results

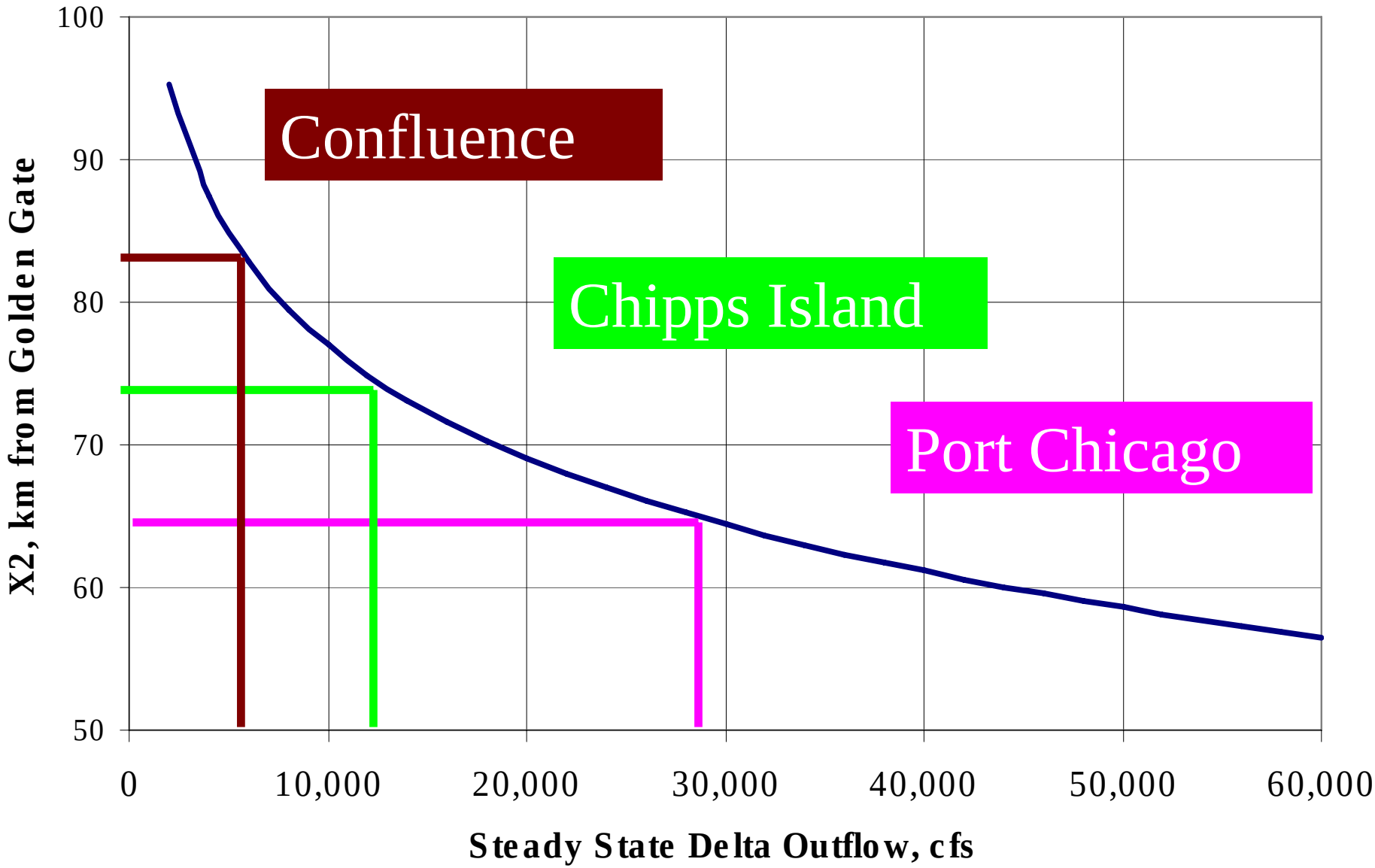
Why Game?

- Responds to SWRCB request.
- Test hypothesis that outflow flexibility can allow for improved overall operational patterns, considering costs and benefits:
  - Species linked to average X2 position
  - Upstream flow fluctuations
  - Upstream carryover storage
  - Supplies for Projects and environment
- Gain insight into possible sideboards.

X2 vs. Steady State Delta Outflow



X2 vs. Steady State Delta Outflow



Participation

Stakeholder (Game 1)

- NOAA Fisheries
- USFWS
- DFG
- DWR
- USBR
- EPA
- SWC
- MWD
- WWD
- SLDMWA
- Bay Institute
- American River Water Forum
- SWRCB Rep

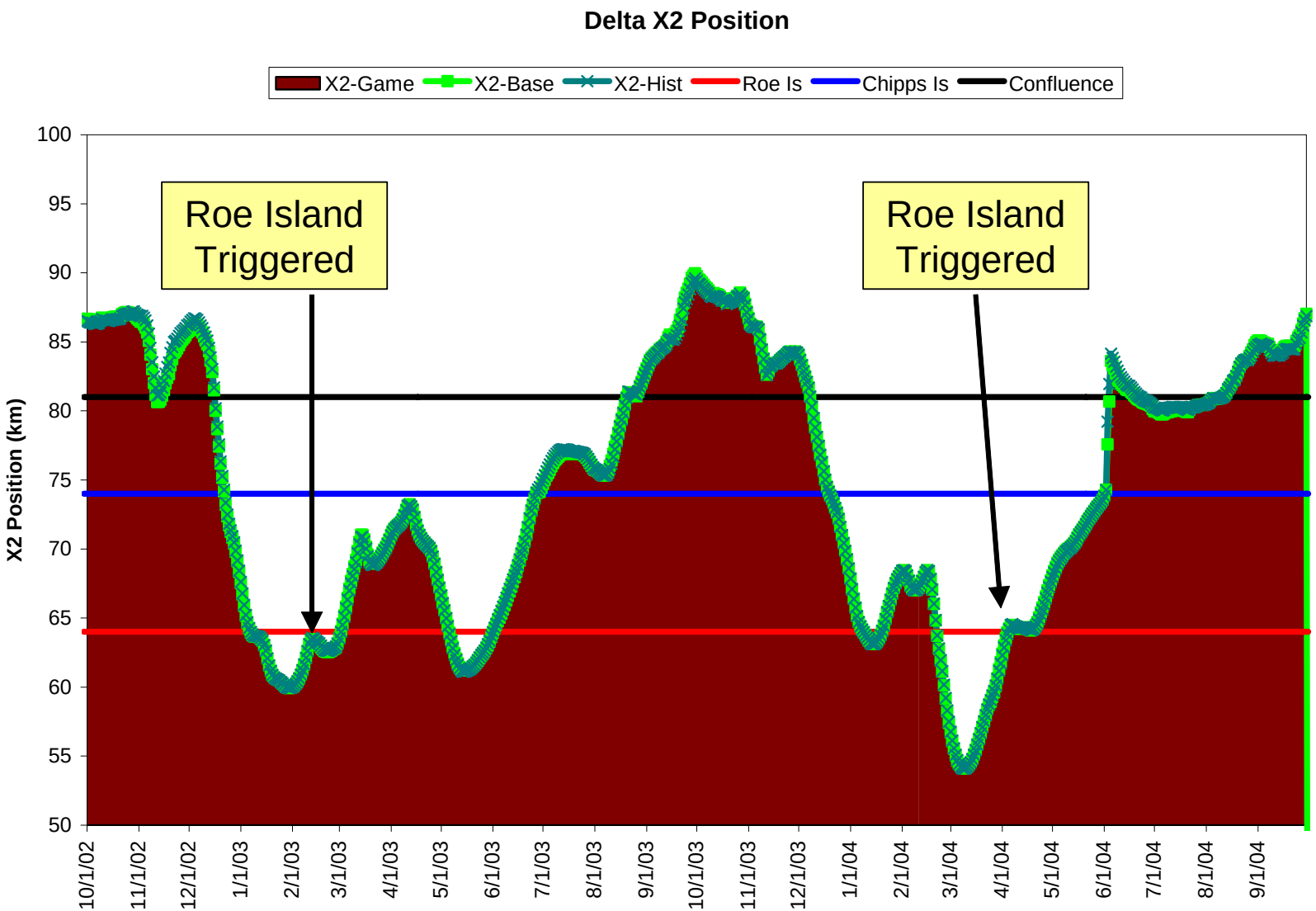
Export Contractor (Games 2 & 3)

- SWP Export Contractors
- CVP Export Contractors

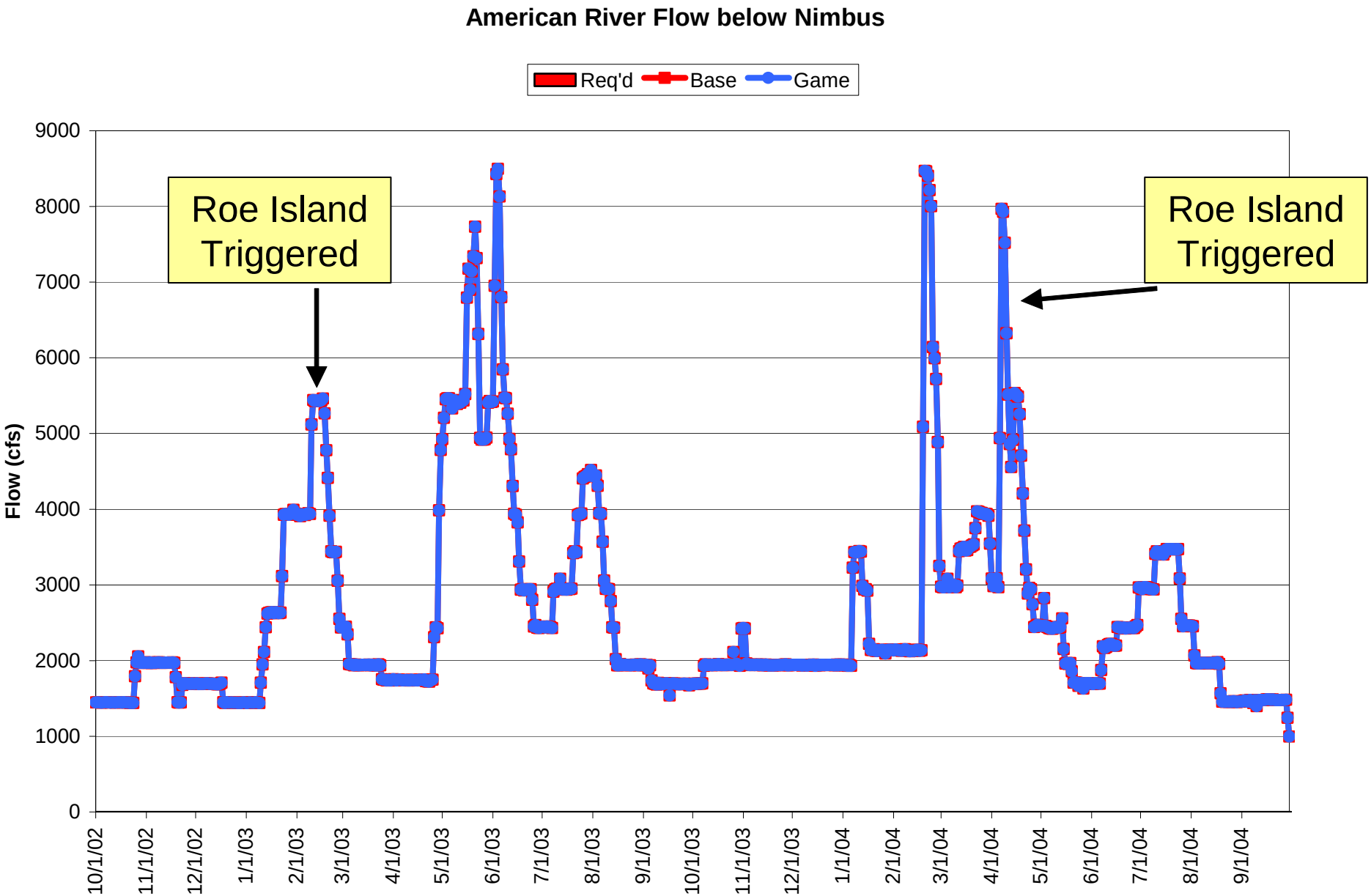
What was Gamed?

- Game 1(April 28, 2005).
- Game 2 & 3 (April 29, 2005)
- Episodes when compliance with X2 caused large upstream releases from storage:
  - February 2003
  - April 2004

X2 Patterns: 2003 and 2004



American R. Patterns 2003 & 2004



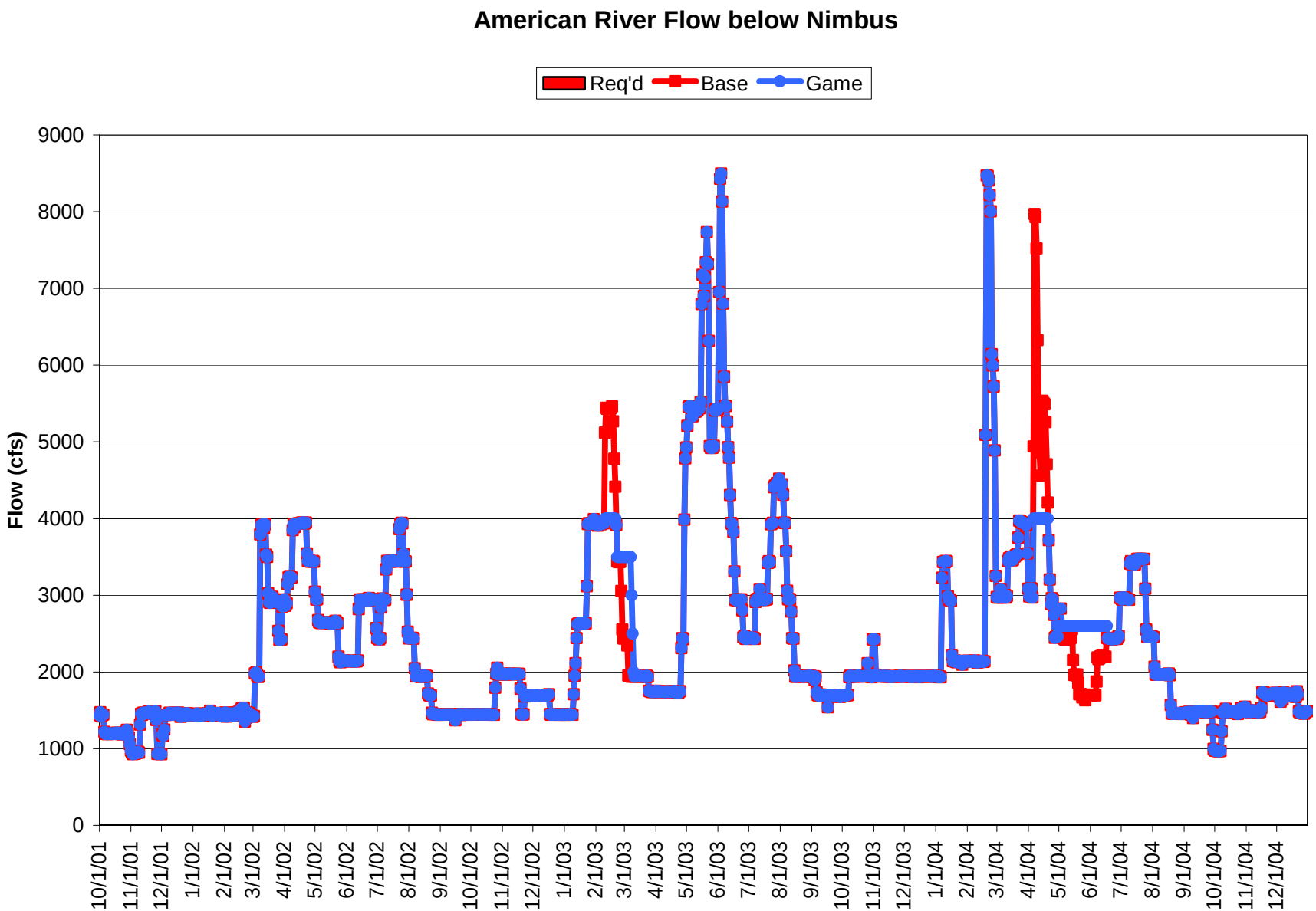
Process of Gaming

- Spreadsheet model
- Start from historic operations
- Try a different operation
- Track changes in flow and parameters related to flow
  - X2
  - Species correlated to X2
  - Storage
  - Upstream flow patterns
  - Exports

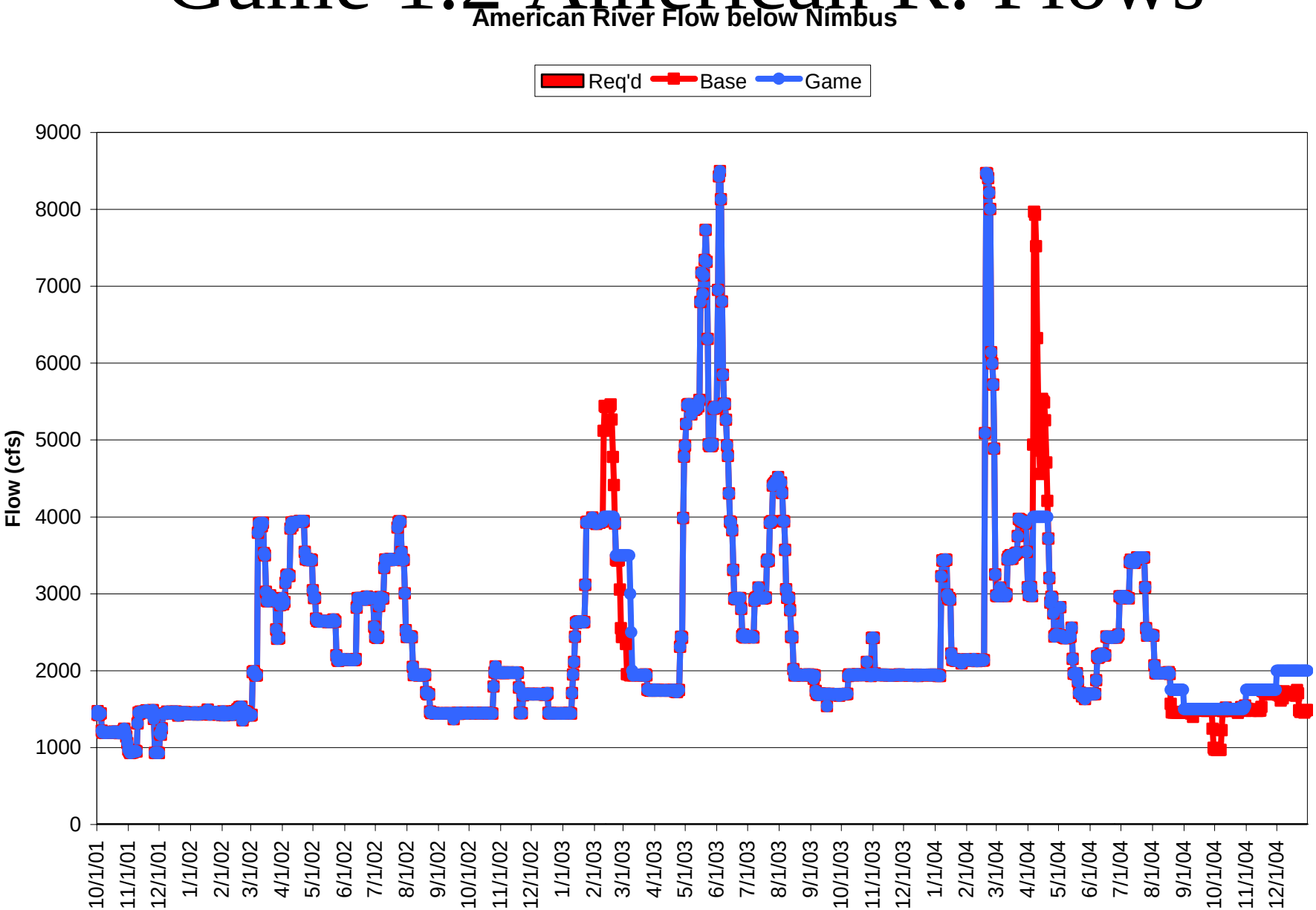
Game 1 Description

- February 2003 and April 2004
- Primary goal: eliminate upward spike in American River flows
- Secondary goals:
  - Game 1.1 Protect/enhance average X2 -- Rerelease water for outflow ASAP
  - Game 1.2 Enhance Folsom storage. Generate flow/export benefits in summer and fall.

Game 1.1 American R Flows



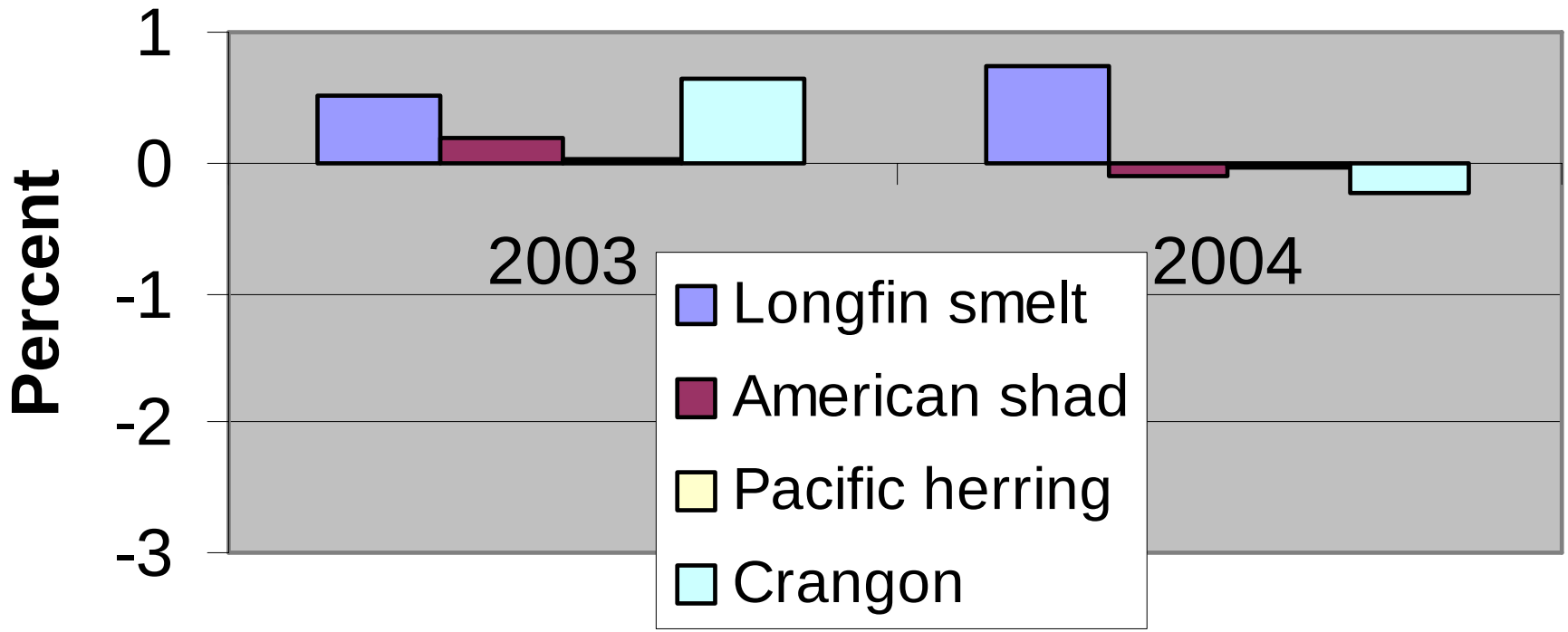
Game 1.2 American R. Flows



Game 1.1 Results

	Feb 2003	Apr 2004
Change in Folsom storage (TAF)	+27 Feb. -27 Feb–Mar	+51 Apr -51 May – Jun
Upstream benefits	No flow spike	No flow spike
Change in Feb – Jun X2	-0.07 km (downstream)	-0.08 km (downstream)
Req'd/Historical/ Final X2 Days	25/26/26	18/23/21
Potential Exports (TAF)	0	0

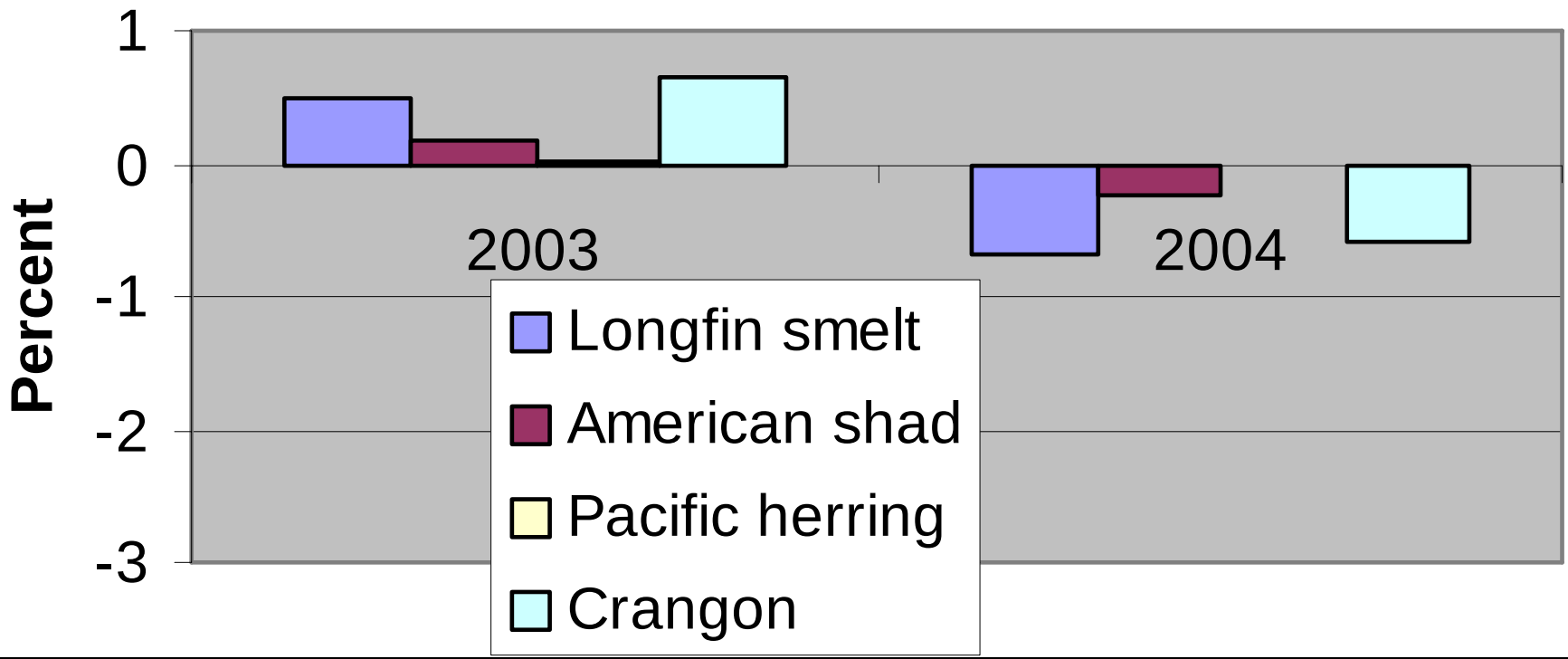
Game 1.1
Changes in Indices linked to X2



Game 1.2 Results

	Feb 2003	Apr 2004
Change in Folsom storage (TAF)	+27 Feb. -27 Feb–Mar	+51 Apr -29 Aug – Nov -22 Post Nov
Upstream benefits	No flow spike	No flow spike. Boost fall releases
Change in Feb – Jun X2	-0.07 km (downstream)	+.06 km (upstream)
Req'd/Historical/ Final X2 Days	25/26/26	18/23/21
Potential Exports (TAF)	0	22

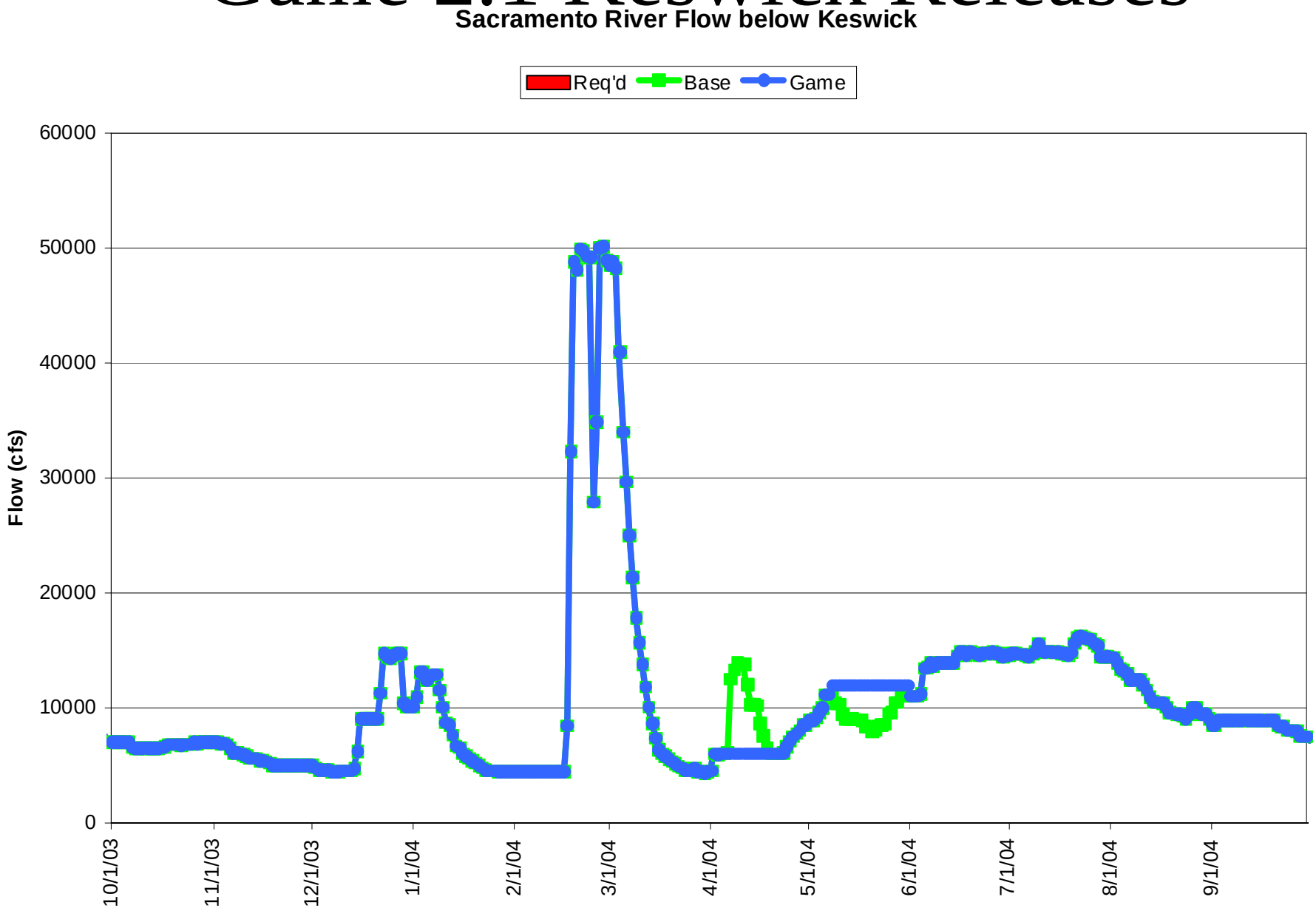
Game 1.2
Changes in Indices linked to X2



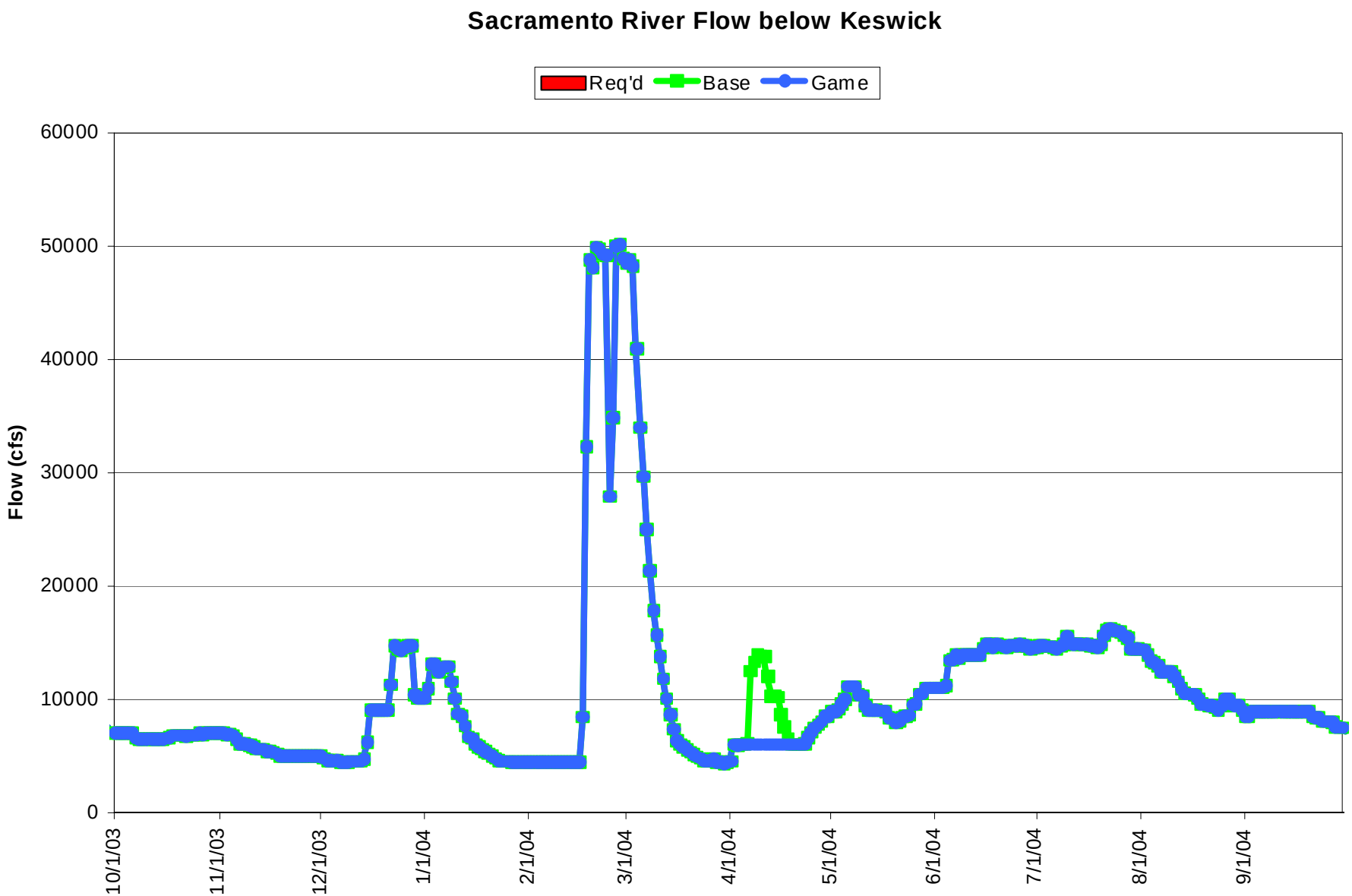
Game 2 Description

- April 2004 only
- Goals
  - Eliminate upward spike in American Sacrmento Rivers.
  - Game 2.1 Protect/enhance average X2 -- Rerelease water for outflow ASAP
  - Game 2.2 Enhance upstream storage. Generate flow/export benefits in summer and fall.

Game 2.1 Keswick Releases



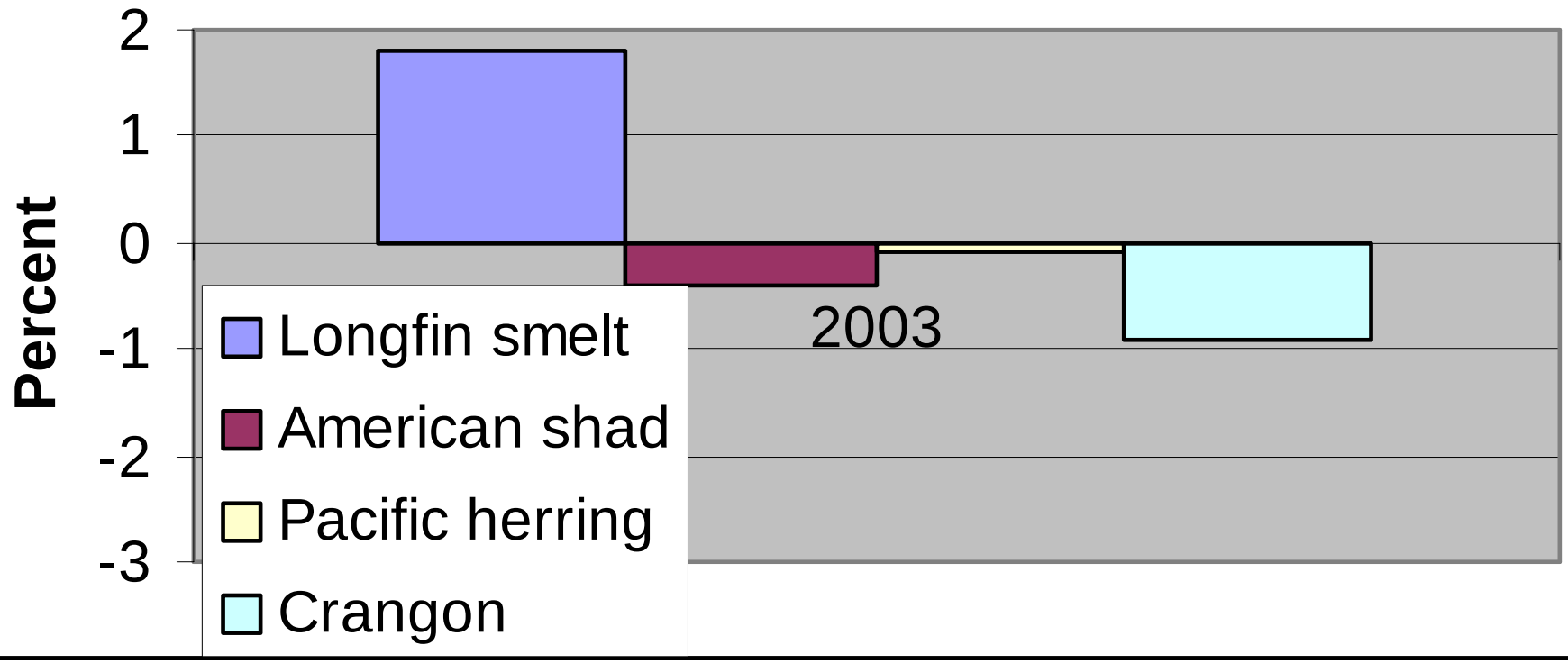
Game 2.2 Keswick Releases



Game 2.1 Results

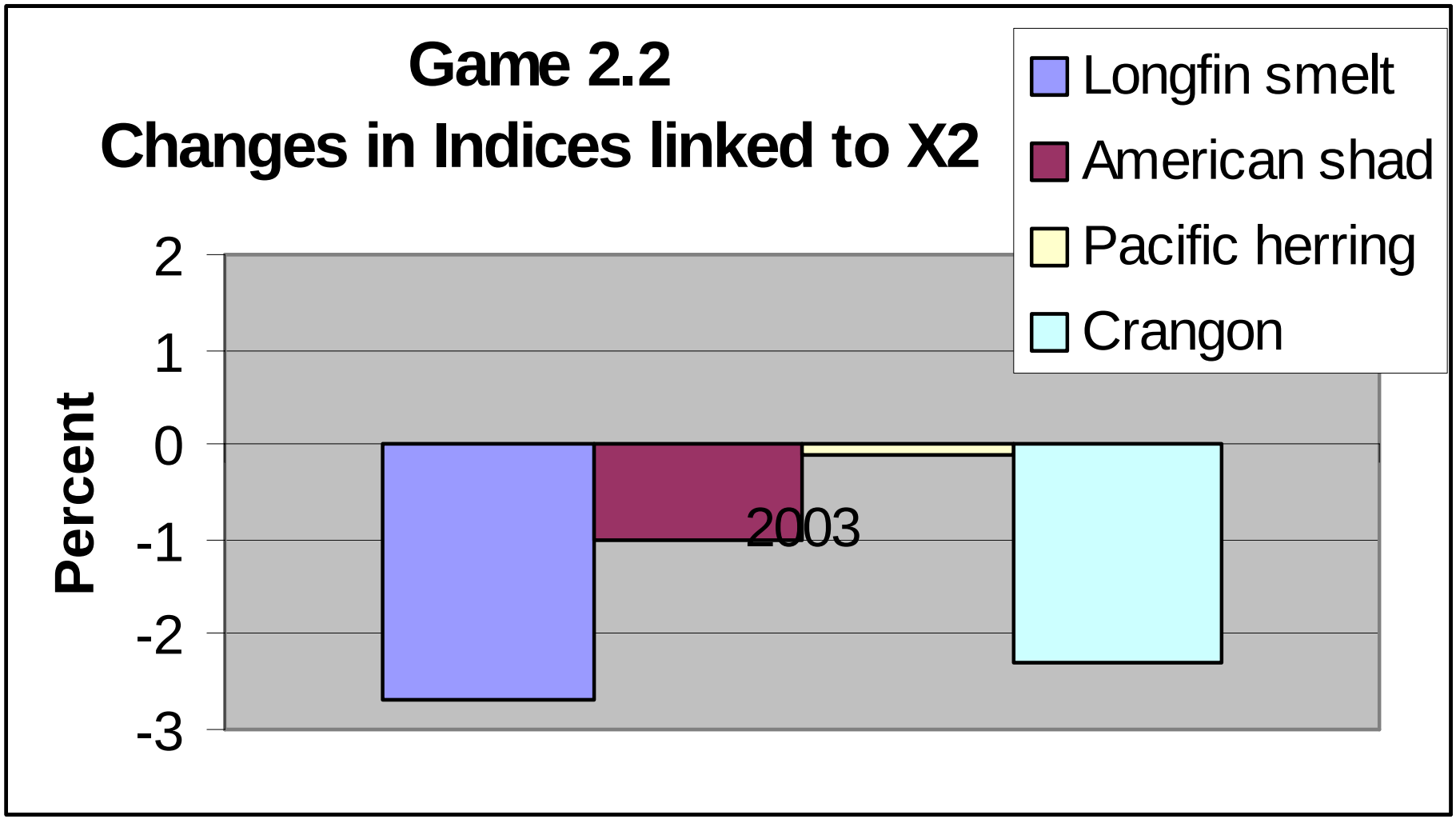
	Apr 2004
Change in upstream storage (TAF)	+172 April -172 May – June
Upstream benefits	No flow spikes
Change in Feb – Jun X2	-0.18 km (downstream)
Req'd/Historical/ Final X2 Days	18/23/17
Potential Exports (TAF)	0

Game 2.1
Changes in Indices linked to X2



Game 2.2 Results

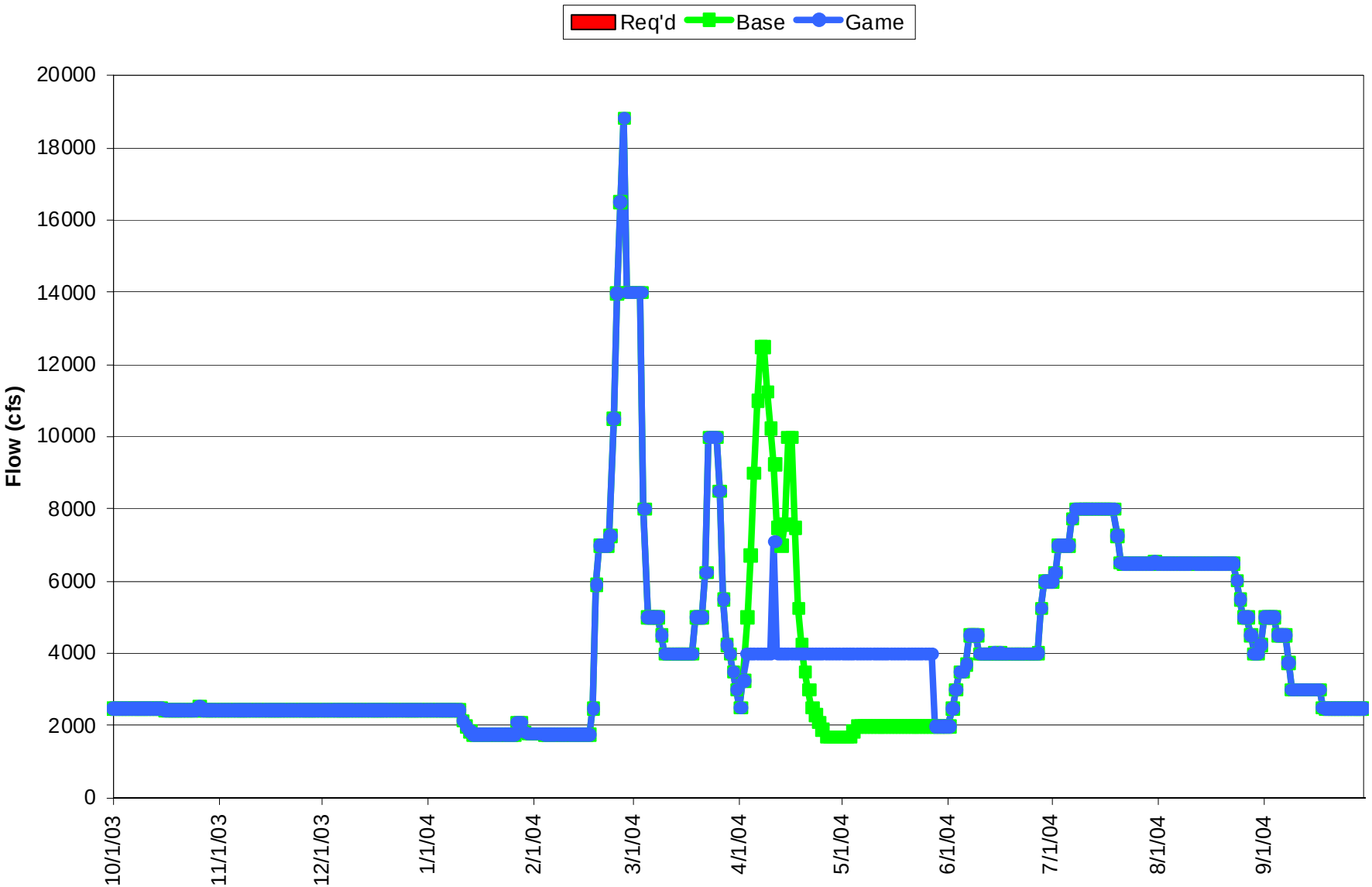
	Apr 2004
Change in upstream storage (TAF)	+172 April -172 Aug – Dec
Upstream benefits	No flow spikes. Boost Fall flows upstream
Change in Feb– Jun X2	0.28 km (upstream)
Req'd/Historical/ Final X2 Days	18/23/17
Potential Exports (TAF)	166


Game 2.2
Changes in Indices linked to X2
Longfin smelt
American shad
Pacific herring
Crangon
Percent
2
1
0
-1
-2
-3
2003

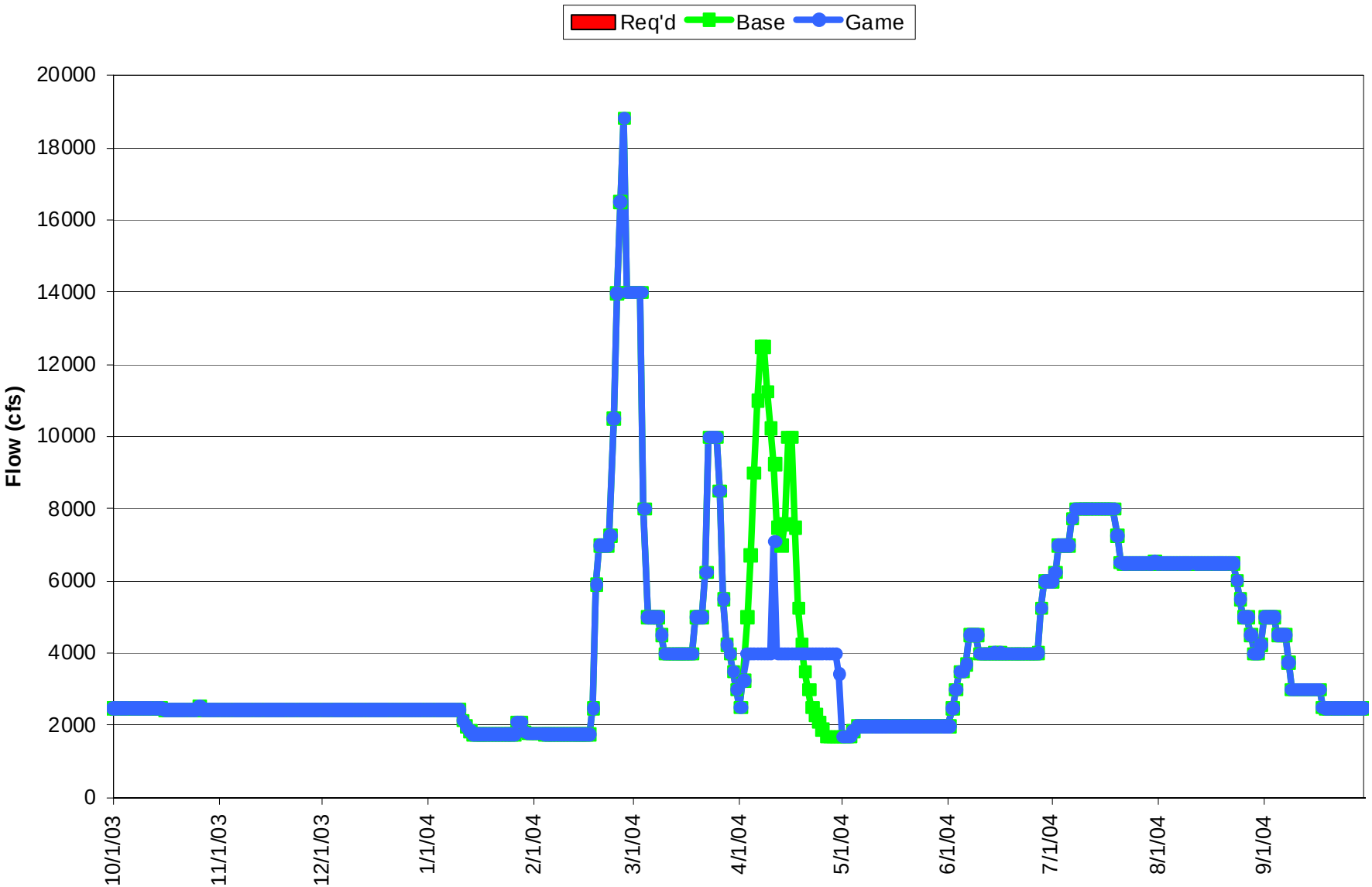
Game 3 Description

- April 2004 only
- Goals
  - Eliminate upward spike in American, Sacramento and Feather Rivers.
  - Game 3.1 Protect/enhance average X2 -- Rerelease water for outflow ASAP.
  - Game 3.3 Keep average X2 constant. Enhance upstream storage. Generate flow/export benefits in summer and fall.

Game 3.1 Feather Flows

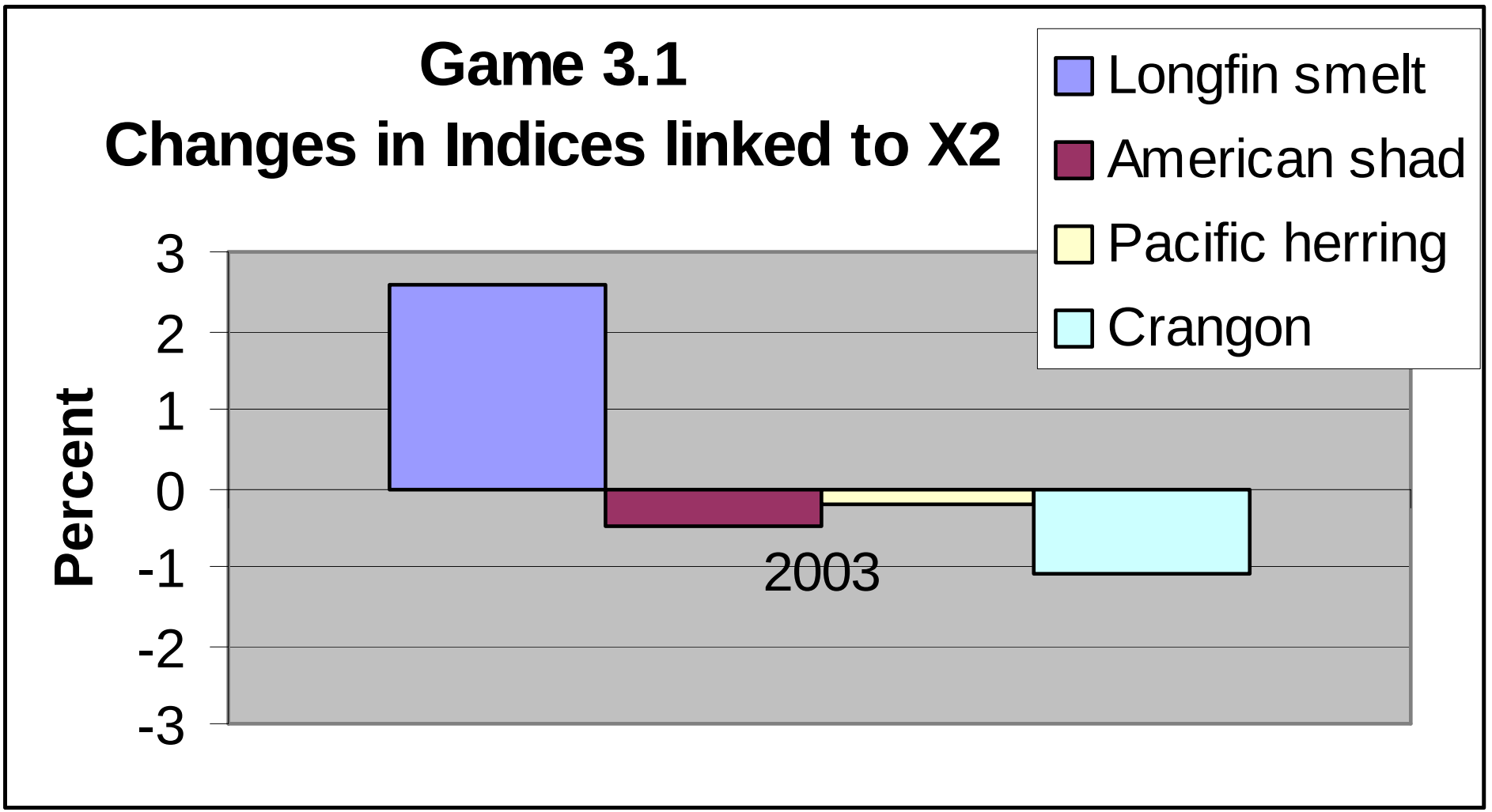


Game 3.3 Feather Flows



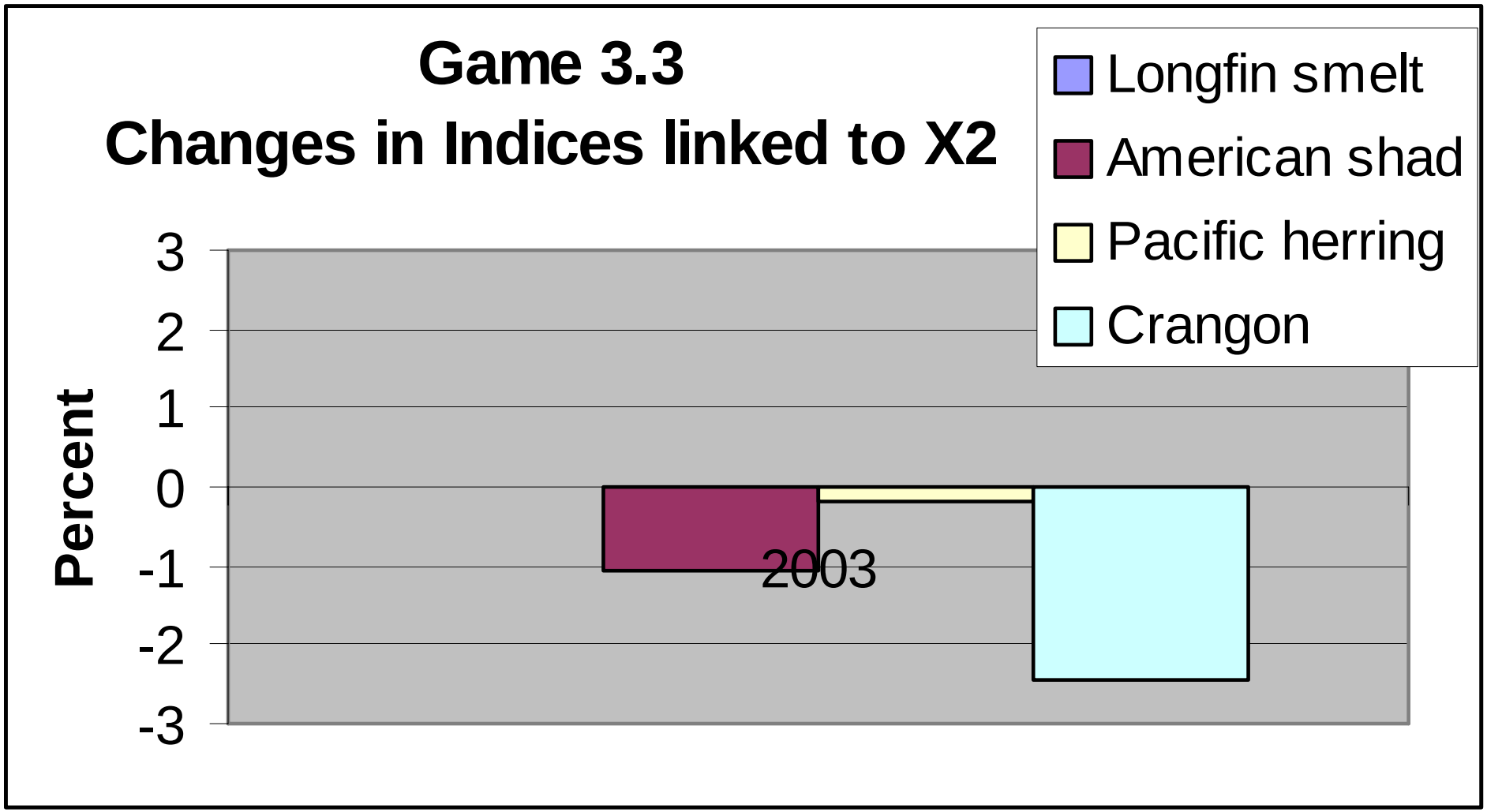
Game 3.1 Results

	Apr 2004
Change in upstream storage (TAF)	+322 April -172 April – June
Upstream benefits	No flow spikes
Change in Feb – Jun X2	-0.25 km (downstream)
Req'd/Historical/ Final X2 Days	18/23/4
Potential Exports (TAF)	0


Game 3.1
Changes in Indices linked to X2
Longfin smelt
American shad
Pacific herring
Crangon
Percent
3
2
1
0
-1
-2
-3
2003

Game 3.3 Results

	Apr 2004
Change in upstream storage (TAF)	+322 April -211 May – June 111 July - Dec
Upstream benefits	No flow spikes. Boost fall releases upstream
Change in Feb – Jun X2	-0.0 km
Req'd/Historical/ Final X2 Days	18/23/4
Potential Exports (TAF)	Approximately 90


Game 3.3
Changes in Indices linked to X2
Longfin smelt
American shad
Pacific herring
Crangon
Percent
3
2
1
0
-1
-2
-3
2003

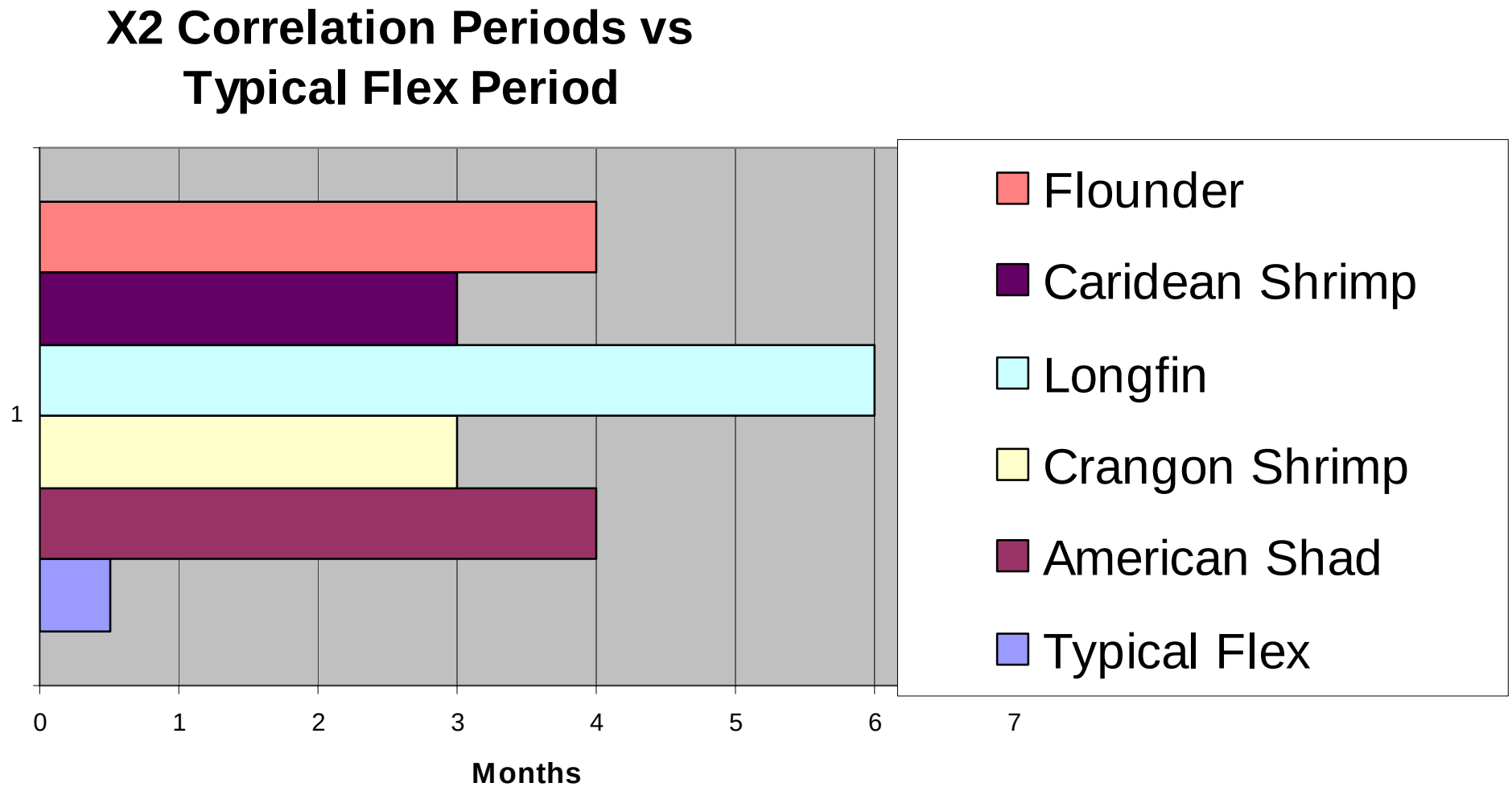
Overcompliance

- Game 1 X2 std met despite “flex”
- Game 2 X2 std nearly met despite 172 TAF reduction in releases.
- Conclusion. Lots of excess releases to comply with X2.
- Compared to simple compliance, impacts to X2 indices are exaggerated.

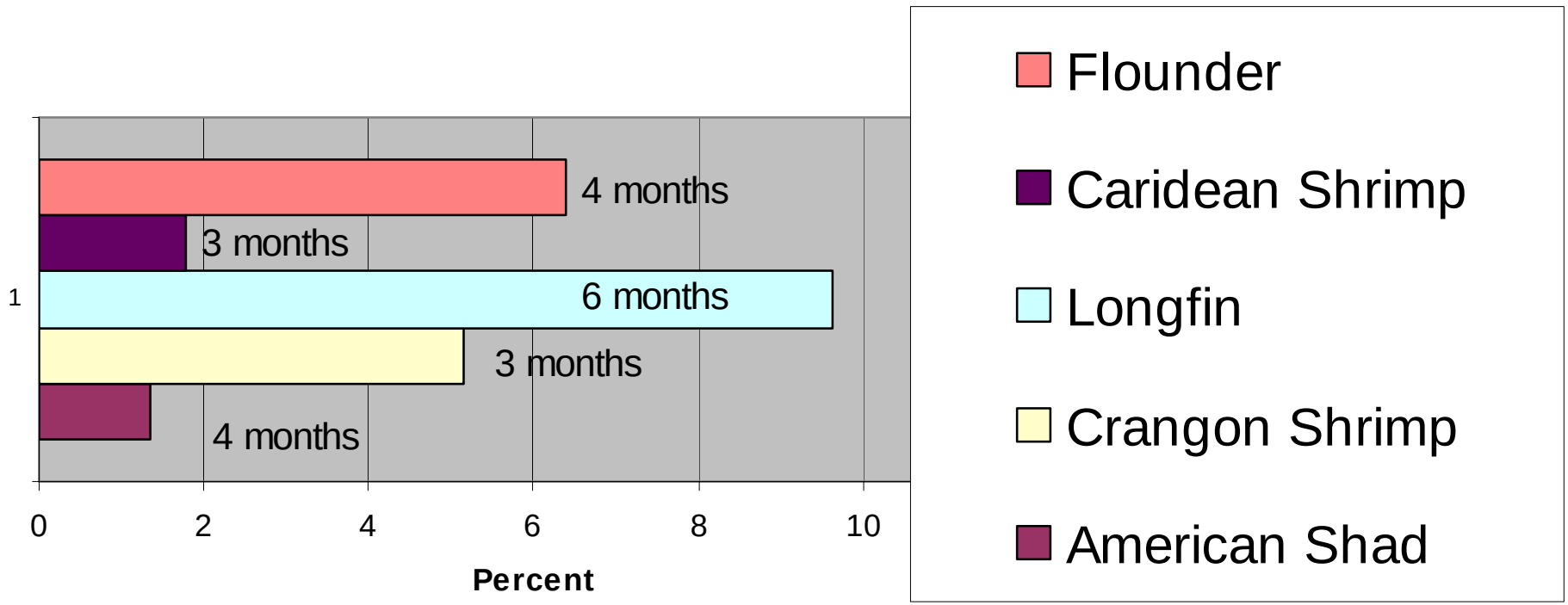
Discussion

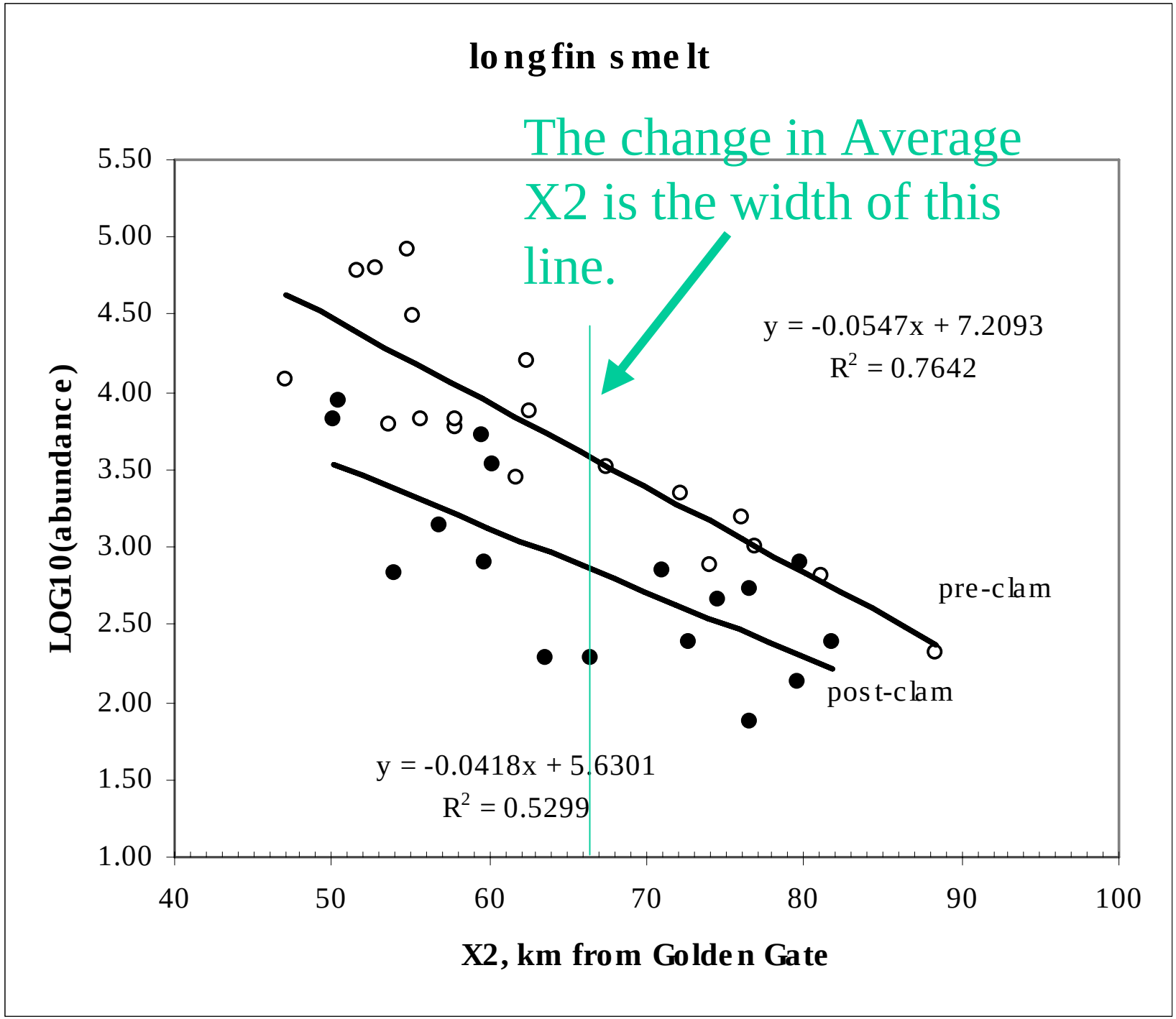
- A variety of flexes possible with various effects.
  - Reduce harmful upstream fluctuations
  - Move average X2 slightly upstream or downstream.
  - Generate upstream storage for flow enhancement, Project supply, EWA supply, etc.

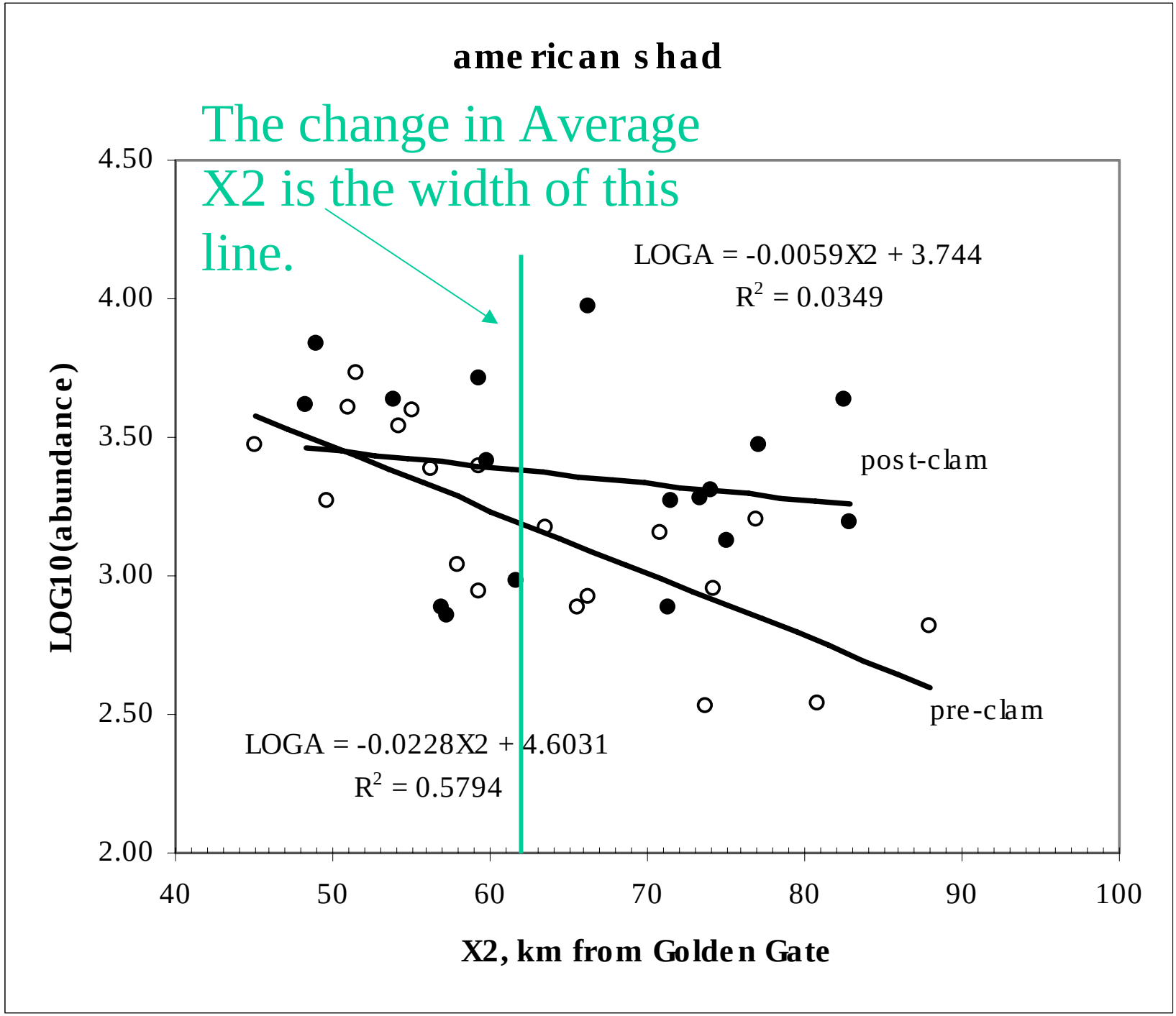
End of Presentation


X2 Correlation Periods vs
Typical Flex Period
1
0
1
2
3
4
5
6
7
Months
Flounder
Caridean Shrimp
Longfin
Crangon Shrimp
American Shad
Typical Flex

Change in Population Index per km change in Average X2 over the Entire Period




longfin smelt
The change in Average X2 is the width of this line.
y = -0.0547x + 7.2093
R2 = 0.7642
pre-clam
post-clam
y = -0.0418x + 5.6301
R2 = 0.5299
LOG10(abundance)
X2, km from Golden Gate
5.50
5.00
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
40
50
60
70
80
90
100


american shad
The change in Average X2 is the width of this line.
LOGA = -0.0059X2 + 3.744
R2 = 0.0349
post-clam
pre-clam
LOGA = -0.0228X2 + 4.6031
R2 = 0.5794
LOG10(abundance)
4.50
4.00
3.50
3.00
2.50
2.00
40
50
60
70
80
90
100
X2, km from Golden Gate