

## **California Sportfishing Protection Alliance**

### ***The Case of the Missing Delta Outflow***

Delta outflow is a critical component in the survival and health of seriously depressed pelagic and anadromous fisheries in the Sacramento-San Joaquin Delta and San Francisco Bay, especially during the present drought. The California Sportfishing Protection Alliance (CSPA) has discovered that actual outflow from the Delta to the Bay are far less than the outflow estimates provided by the State Water Resources Control Board (SWRCB), U.S. Bureau of Reclamation (USBR) and California Department of Water Resources (DWR).

CSPA found that where the agencies claimed that Delta Outflow during May 2014 was 3805 cubic foot seconds (cfs), the actual Delta Outflow was a minus 45 cfs. Similar discrepancies were found in other months. Moreover, DWR and the USBR have long known their claims of Delta Outflow seriously overestimated actual outflow in lower flow periods.

Delta outflow is a key regulatory value under both the 2008 Delta Smelt Biological Opinion and SWRCB Order D-1641. D-1641 regulates minimum Delta outflows by way of a calculated index known as the Net Delta Outflow Index (NDOI). The SWRCB, USBR and DWR employ NDOI as a representation of Delta outflow to San Pablo and San Francisco Bays.

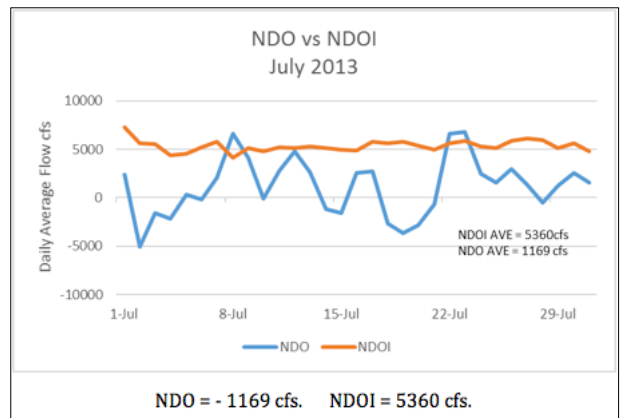
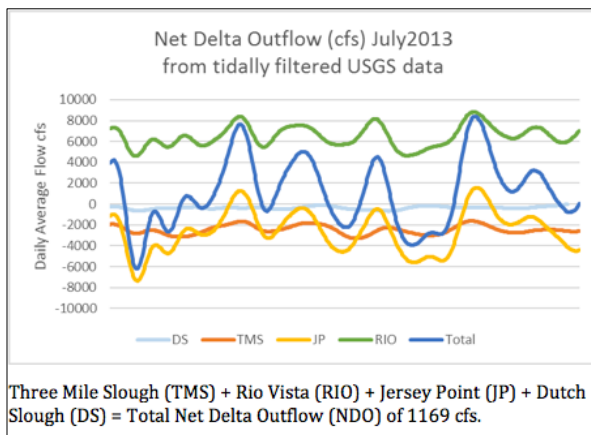
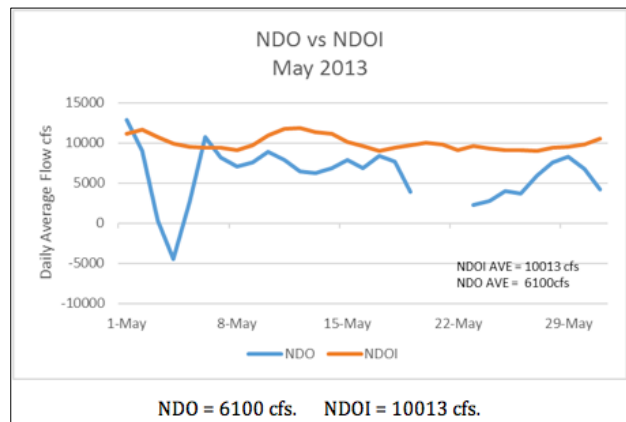
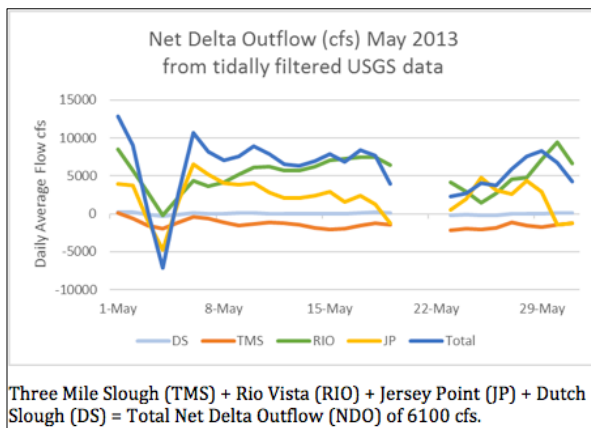
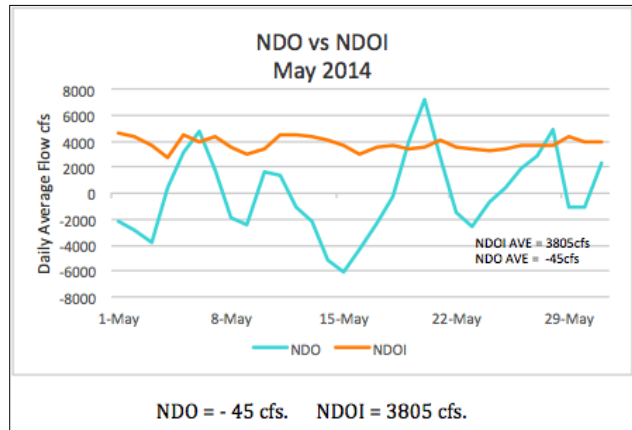
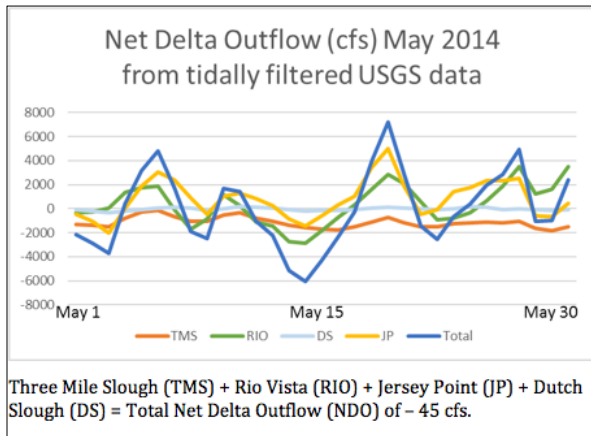
The NDOI is a complex formula roughly computed as Delta Inflow minus Net Delta Consumptive Use minus Delta Exports. Each of these flow values is calculated from a number of more specific values, some of which are direct measurements of flow, and others of which are estimates. For example, inflows to the Delta from the major rivers are gaged and directly monitored but diversions of water for in Delta use or agricultural return flows are unknown, so they are estimated. Not all Delta inflows are monitored and they too are estimated.

While the NDOI is, at best, an estimate of Delta outflow, there are stations that accurately measure actual Delta outflow. The United States Geological Survey (USGS) has established a series of stations in the Delta to measure flow and water quality parameters. Most of these stations employ state-of-the-art acoustic Doppler measuring devices that bounce sound waves off particles in the water across entire river channels. These highly accurate gages can measure flow and tides to within one percent. While daily peak tidal flows can be on the order of 150,000 cubic feet per second (cfs), the net flow may be negative.

Four of the USGS gaging stations on the Sacramento River at Rio Vista, San Joaquin River at Jersey Point, Three-mile Slough and Dutch Slough collectively and accurately measure Net Delta Outflow (NDO). These stations report flow, tidally filtered flow, gage height, velocity as well as various water quality parameters.

CSPA collected and analyzed the USGS tidally filtered NDO data for May and July 2013 and May 2014 and compared it with the NDOI reported by DWR and USBR. Below are the results of that analysis, the formula included in D-1641 to compute the NDOI and links to more complete documentation on how the NDOI is calculated and comparisons of NDOI with NDO found on various DWR websites.

Net Delta Outflow (NDO), based on direct measurements at four USGS state-of-the-art gaging stations was less than estimated NDOI during the months of May 2013, July 2013 and May 2014 by approximately 3913 cfs, 4191 cfs and 3850 cfs, respectively.



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5 June, 2014

Bill Jennings, Executive Director  
California Sportfishing Protection Alliance  
3536 Rainier Avenue  
Stockton, CA 95204

Dear Bill,

I have reviewed the daily Delta Outflow data for May as provided by USBR Central Valley Office (CVO): <http://www.usbr.gov/mp/cvo/vungvari/dout0514.pdf>. These data represent the Net Delta Outflow Index (NDOI) as defined at:

<http://www.water.ca.gov/dayflow/output/inputdata.cfm>

I also calculated the Net Delta Outflow (NDO) (Figure 1) as defined for USGS UVM flow meters at:

<http://www.water.ca.gov/dayflow/ndoVsNdoi/>

In the comparison between the two methodologies provided in the above website, the conclusion is that the NDOI compares favorably with actual measures of NDO. But, this conclusion is based on a comparison of the old UVM flow meters and NDOI data collected between 1996 and 2000.

It should be noted that the NDOI is based upon a rather involved formula that uses a combination of reported and estimated data. For example, in Delta channel depletion is based on a general estimate of in Delta water consumption. Further, the estimated NDOI does not account for tides.

In recent years, USGS replaced the old UVM flow meters with highly accurate state-of-the-art Doppler flow meters to more accurately determine Delta outflows. I calculated NDO from the provided equation and tidally-filtered data provided by USGS website: <http://waterdata.usgs.gov/nwis/>.

It is obvious that the two methods are no longer comparable (Figure 2) and indicates that the NDOI grossly overestimates the actual Delta outflow. The averages for May 2014 are as follows:

NDOI = 3805 cubic foot seconds (cfs)

NDO = - 45 cfs

The discrepancy is striking. The NDOI indicates that Delta outflow was 3805 cfs, while the NDO indicates that Delta outflow was actually negative. The difference between the two estimates is of great concern because Delta outflow is a key component of the low salinity zone location and productivity, which is directly related to Delta smelt and Longfin smelt survival. Recent State Board orders have relaxed D-1641 Delta standards for May and July for Delta outflow from 4000 cfs to 3000 cfs, which if based on the NDOI will greatly misrepresent actual Delta outflow.

Sincerely yours,



Thomas Cannon

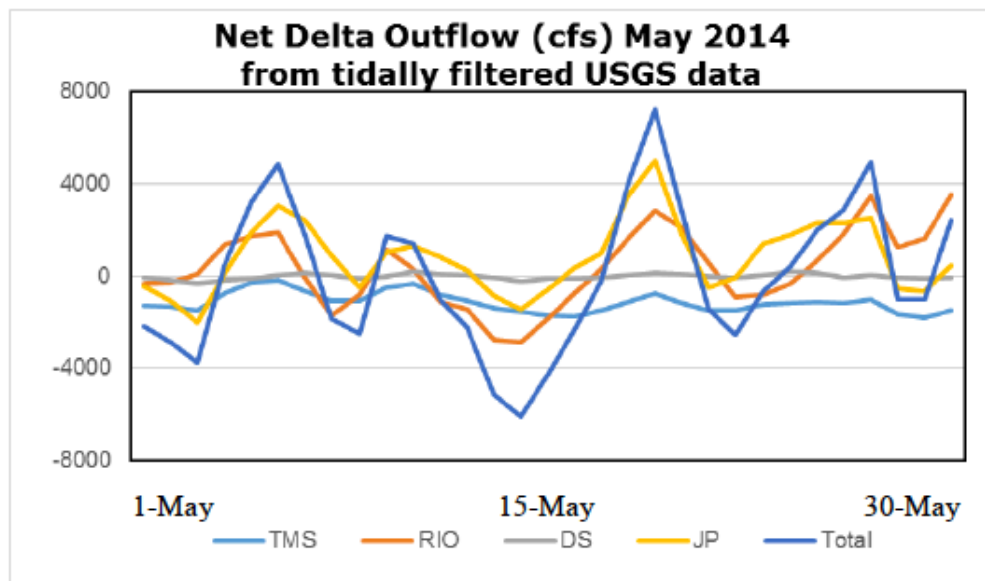


Figure 1. Daily Net Delta Outflow (Total) = Three Mile Slough (TMS) + Rio Vista (RIO) + Dutch S1 (DS) + Jersey Pt (JP), May 2014.

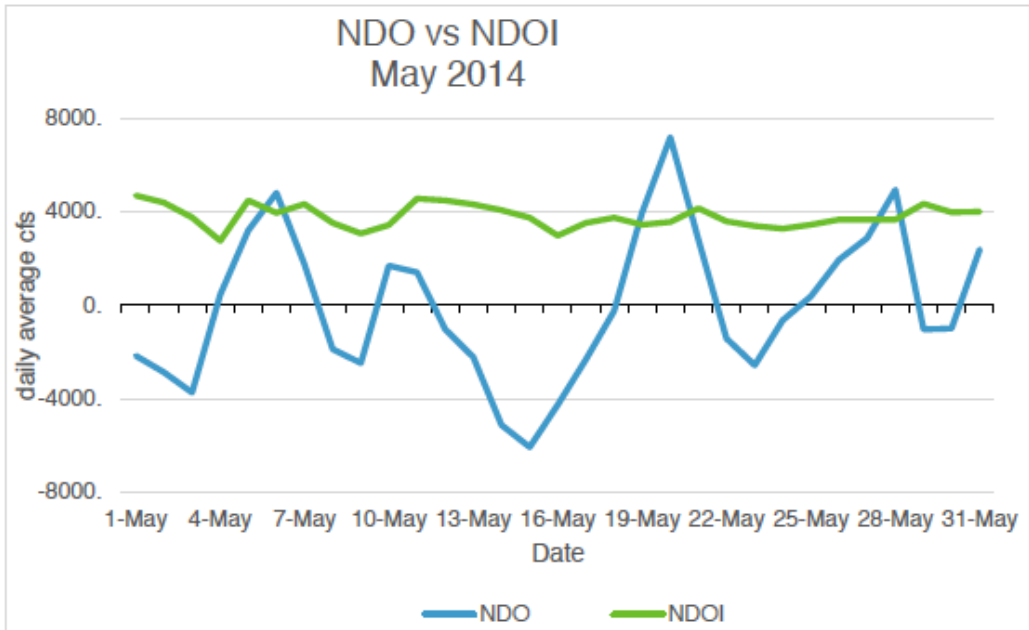


Figure 2. Comparison of Daily NDOI vs NDO for May 2014.

State Water Resources Control Board Order D-1641, p. 190, Figure 3, describes the formula for estimating the Net Delta Outflow Index. Each of the flow values is calculated from a number of more specific values, some of which are direct measurements, and others of which are estimates.

**Figure 3**  
**NDOI and PERCENT INFLOW DIVERTED<sup>1</sup>**

The NDOI and the percent inflow diverted, as described in this footnote, shall be computed daily by the DWR and the USBR using the following formulas (all flows are in cfs):

$$NDOI = DELTA\ INFLOW - NET\ DELTA\ CONSUMPTIVE\ USE - DELTA\ EXPORTS$$

$$PERCENT\ INFLOW\ DIVERTED = (CCF + TPP) \div DELTA\ INFLOW$$

where  $DELTA\ INFLOW = SAC + SRTP + YOLO + EAST + MISC + SJR$

- SAC* = Sacramento River at Freeport mean daily flow for the previous day; the 25-hour tidal cycle measurements from 12:00 midnight to 1:00 a.m. may be used instead.
- SRTP* = Sacramento Regional Treatment Plant average daily discharge for the previous week.
- YOLO* = Yolo Bypass mean daily flow for the previous day, which is equal to the flows from the Sacramento Weir, Fremont Weir, Cache Creek at Rumsey, and the South Fork of Putah Creek.
- EAST* = Eastside Streams mean daily flow for the previous day from the Mokelumne River at Woodbridge, Cosumnes River at Michigan Bar, and Calaveras River at Bellota.
- MISC* = Combined mean daily flow for the previous day of Bear Creek, Dry Creek, Stockton Diverting Canal, French Camp Slough, Marsh Creek, and Morrison Creek.
- SJR* = San Joaquin River flow at Vernalis, mean daily flow for the previous day.

where  $NET\ DELTA\ CONSUMPTIVE\ USE = GDEPL - PREC$

- GDEPL* = Delta gross channel depletion for the previous day based on water year type using the DWR's latest Delta land use study.<sup>2</sup>
- PREC* = Real-time Delta precipitation runoff for the previous day estimated from stations within the Delta.

and where  $DELTA\ EXPORTS^3 = CCF + TPP + CCC + NBA$

- CCF* = Clifton Court Forebay inflow for the current day.<sup>4</sup>
- TPP* = Tracy Pumping Plant pumping for the current day.
- CCC* = Contra Costa Canal pumping for the current day.
- NBA* = North Bay Aqueduct pumping for the current day.

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1 Not all of the Delta tributary streams are gaged and telemetered. When appropriate, other methods of estimating stream flows, such as correlations with precipitation or runoff from nearby streams, may be used instead.

2 The DWR is currently developing new channel depletion estimates. If these new estimates are not available, DAYFLOW channel depletion estimates shall be used.

3 The term "Delta Exports" is used only to calculate the NDOI. It is not intended to distinguish among the listed diversions with respect to eligibility for protection under the area of origin provisions of the California Water Code.

4 Actual Byron-Bethany Irrigation District withdrawals from Clifton Court Forebay shall be subtracted from Clifton Court Forebay inflow. (Byron-Bethany Irrigation District water use is incorporated into the GDEPL term.)

The Department of Water Resources has compared NDOI with NDO on its web page entitled “An estimate of Daily Average Delta Outflow” at:  
[http://www.water.ca.gov/dayflow/docs/2013\\_Comments.pdf](http://www.water.ca.gov/dayflow/docs/2013_Comments.pdf)

### Dayflow 2013 Water Year Comments

- Dayflow data inputs for 2013 were obtained from the following sources:

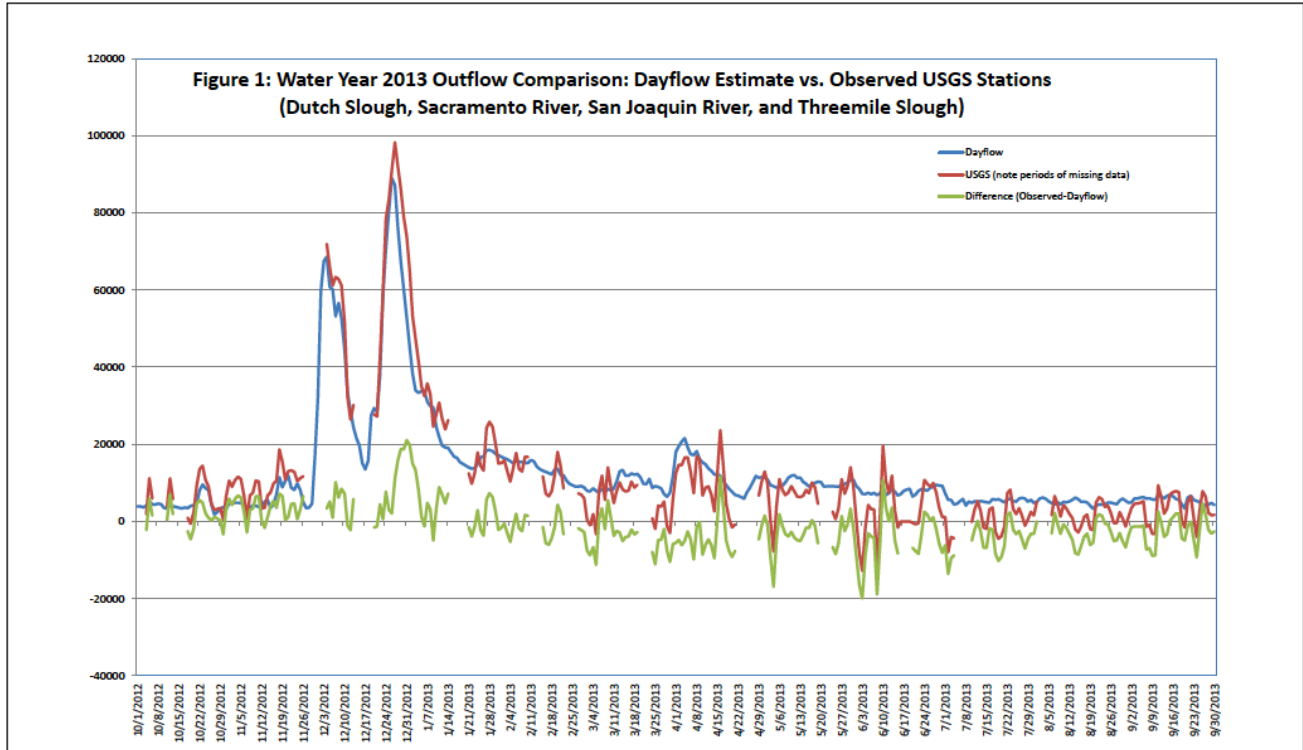
Data Input	Source
Sacramento Weir Flow	DWR
Delta Cross Channel Gate Operations	DWR
Clifton Court Inflows	DWR
Barker Slough	DWR
Miscellaneous Flood Events	DWR
Stockton Fire Station Precipitation	DWR
Byron Bethany Irrigation District	DWR
Mokelumne River at Woodbridge	EBMUD
Tracy Pumping Plant	USBR
Rock Slough	USBR
Old River	USBR
Putah Creek & Putah South Canal	USBR
Middle River at Victoria	USBR

- 2013 inputs for the following stations were obtained from the responsible agency’s website and are “provisional data” that will be finalized by the responsible agency sometime during the next year.

USGS Site #	Site
11303500	San Joaquin River near Vernalis
11335000	Cosumnes River at Michigan Bar
11336600	Delta Cross Channel near Walnut Grove
11447650	Sacramento River at Freeport
11447903	Georgiana Slough near Sacramento River
11453000	Yolo Bypass near Woodland

USACOE #	Site
NHG	Calaveras River below New Hogan Dam

- Most questions regarding Dayflow can be found in the “Dayflow Documentation” found here:  
<http://www.water.ca.gov/dayflow/documentation/>
- Figure 1 shows a comparison of Dayflow estimated outflow to observed USGS flow stations (Dutch Slough at Jersey Island, Sacramento River at Rio Vista, San Joaquin River at Jersey Point, and Threemile Slough at Rio Vista). Dayflow estimated outflow follows the general trend of the USGS observed stations. Dayflow under estimates flow during wet periods and over estimates flow during dry periods. Note that the observed data has more variability due to the spring-neap cycle which Dayflow does not account for.



The many values on which NDOI is calculated are further described by the Department of Water Resources at:

<http://www.water.ca.gov/dayflow/documentation/>

<http://www.water.ca.gov/dayflow/documentation/dayflowDoc.cfm#Computational%20Scheme%20Part%201>

<http://www.water.ca.gov/dayflow/ndoVsNdoi/>