February 12, 2010

SWRCB Proceeding on Delta Flow Criteria

The Nature Conservancy Exhibit 2 – Historical Context of Delta Freshwater Flow in Relation to Other Uses that Deplete Water from the Delta Watershed

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Purpose

The purposes of the figures presented in this paper are to 1) provide historical context of Delta freshwater outflows in relation to other uses that deplete water from the Delta watershed, and 2) illustrate how the ratio between the quantity of freshwater outflow and these other depletions has changed through time in recent decades.

Summary

As demonstrated by the figures included on the following pages, since the 1930s there has been a fundamental shift in the proportion of total Delta watershed water supplies that makes up Delta outflow. This shift has been occurring progressively over several decades and is noticeable even in the wetter years. This downward trend is most noticeable when looking at the combined "Dry" and "Critical" year-types.

Another important pattern illustrated by the figures is that the recent combined depletions from the Delta watershed stay relatively consistent across different year types. While the total water supply into the Delta watershed varies widely from year to year due to natural hydrologic variability, there is comparatively little variation in total depletions between wetter and dryer years.
TNC Exhibit 3 highlights how freshwater flows to estuaries such as the Delta are a critical component of the health of estuarine. In the context of the wide body of evidence summarized in TNC exhibit 3 and the Delta-specific evidence provided by the testimony of The Bay Institute and others, the trends highlighted here, including the erosion of the proportion of total water going to freshwater outflow and the dampening of natural inter-annual variability patterns are likely to exacerbate existing trends in ecologic health of the Delta.

There are workable solutions that allow those who benefit from depletions – upstream, in the Delta and export areas – to continue to benefit. Halting and

reversing the trends highlighted here will require greater conjunctive use of groundwater and surface water resources. It will require greater flexibility for diverters to change when and how much they divert – increasing diversion rates and storing water to allow for temporary shifting across months and across years. Last, it may require new and creative water management strategies in the water distribution system as well as state and federal project operations. Delta outflow criteria that support, encourage, and facilitate these improvements in practice are an important piece of the process toward restoring the Delta ecosystem.

Data Categories and Sources:

The figures presented in this paper are based on the annual data used to develop Figure 7b in the Delta Vision (January 29, 2008 p. 37). This data set – providing annual values from 1930 to 2005 – was organized into four categories, and then averaged for the values within each decade (e.g. 1930 to 1939, 1940 to 1949, etc.). The categories and data sources include:

1. **Delta outflow** – this subset of data, generated by Dayflow and included in an Excel file named: "Dayflow_NDOI_29-02.xls," was made available to the State Water Contractors and CALFED staff during development of the Delta Vision.

2. **Export Depletions** – This data set includes CVP and SWP diversions at the south Delta as well as diversions at the North Bay Aqueduct. All data was contained in the Dayflow Excel file named above.

3. **In-Delta Depletions** – This group reflects the data set made available to CALFED staff for the Delta Vision effort from Mike Citro, URS Corporation, Oakland Office (510.874.1739), October 19, 2007 (file name: "In Delta Water Use.xls"). In-Delta Diversions are estimated as the net of diversions, seepage, and drainage values from DICU developed for DSM2.

   The annual historic diversion records from Contra Costa Water District were added to the URS data set to complete the "In-Delta Depletions."

4. **Upstream Depletions** – Though the data set used for this category represents "consumptive use of applied water" for the Sacramento River and San Joaquin River basins derived from both surface water and groundwater, it is used as a proxy for demonstrating increased consumption of water resources over time. Historically, the ratio of groundwater and surface water applied in upstream areas has been fairly consistent even when hydrology varies. Coupled with the complexity of surface and groundwater interaction in upstream watersheds, return flows originating from both surface and ground sources, and other factors that have limited the development of a comparable data set, this data set was believed to be representative of the magnitude and variances in total upstream diversions. The data for San Joaquin River and Sacramento River basins was from C2VSIM Run-321 (Historical), and provided to CALFED for Delta Vision efforts by Tariq Nadir

(DWR) (file name: "CUAW for ADvorak SWC 10-26-07.xls").

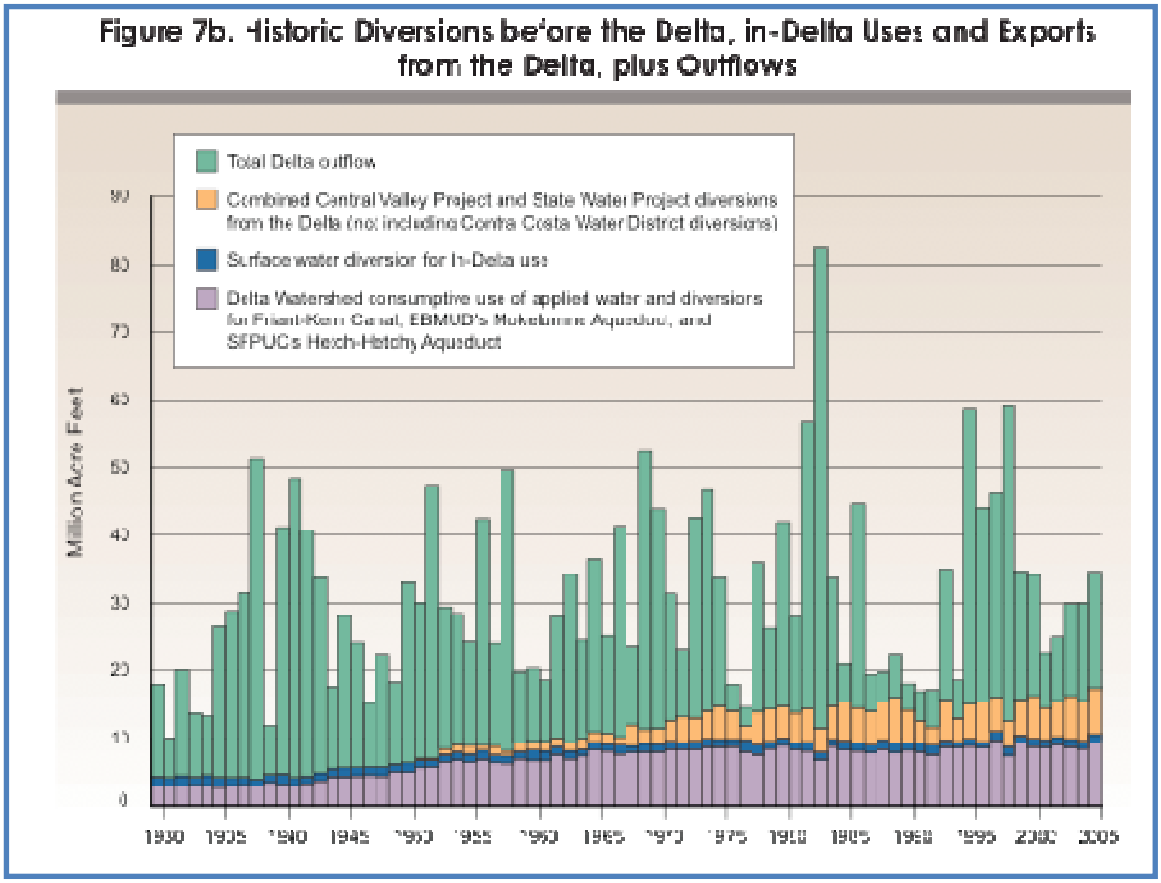
Historic annual diversions were added to the Sacramento and San Joaquin consumptive use data for diversions that remove water out of the upstream watersheds for 1) Hetch-Hetchy Aqueduct (source: SANJASM documentation), 2) Mokelumne Aqueduct (source: EBMUD), and 3) Friant-Kern Canal (source: USGS).

These four data categories, when added together for each year, represent the "total water" available to the Delta system. The subset of the In-Delta, Upstream, and Export depletion values represents the total "depletions" from the system – water not available for outflow.

For Delta Vision, data from these four categories were presented as a series of 76 annual stacked columns (see **Figure 1**). For purpose of providing historical context, The Nature Conservancy wanted to analyze unique groupings of the data – separately looking at the conditions under different water year-type designations. To smooth some of the variability that results from the frequency and magnitude of values under the various year-type categories, the data was grouped into 10-year periods – representing each decade. Averaging the data for the years within one period under the following sub-groupings provided the data used to generate the remaining figures. These sub-groupings within each 10-year data set included:

1. All 10 years
2. Critical and Dry years only
3. Below Normal and Above Normal years only
4. Above Normal and Wet years only.

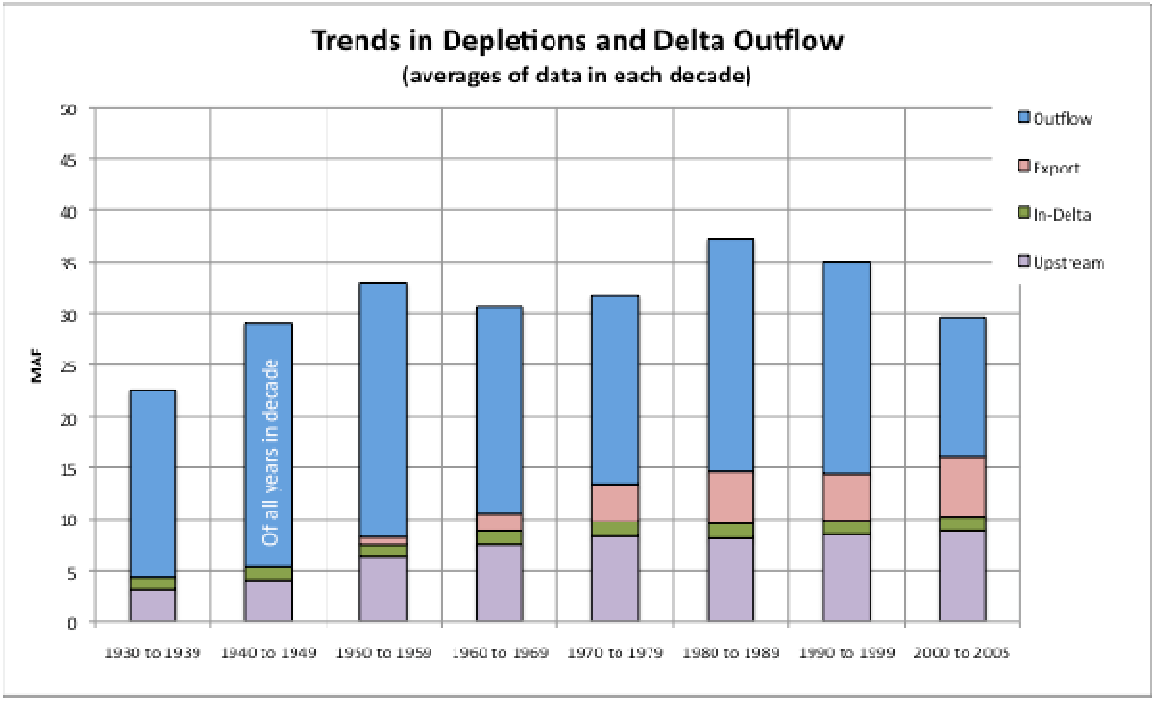
Figure 1 – Figure 7b from the Delta Vision Strategic Plan (October 2008)



Resulting Historical Context

As with the Delta Vision graphic, **Figure 2** demonstrates the increase in all depletions as has historically occurred with increased demand in upstream areas, as well as completion of state and federal projects. The only difference between **Figure 1** (as presented in the January 2008 Delta Vision document) and **Figure 2** is that **Figure 2** represents the averaging of the four data categories for ten years of record in each decade.

Figure 2 – Averages for All Year Types



As shown in **Figure 3**, when the data representing only the defined "Critical and Dry" years within each decade is averaged and placed next to the full 76-year averages, the reduction in average Delta freshwater outflow is apparent (top color in each stacked column). The "Critical and Dry" columns are to the right of the "All Years" columns. Of course, outflows under natural conditions would be much lower during dryer years, but as illustrated here, there is little reduction in total depletions (exports + delta and upstream depletions), resulting in a great exaggeration of low outflow volumes in dryer years.

Figure 4 presents the average values for the "Above Normal and Wet" sub-grouping of years that occur within each decade. As expected, the outflow values, when compared to the other average values, increases significantly. The "Above Normal and Wet" columns are to the left of the "All Years" columns.

Figure 3 – Averages for "Dry and Critical" Year-types compared to "All"

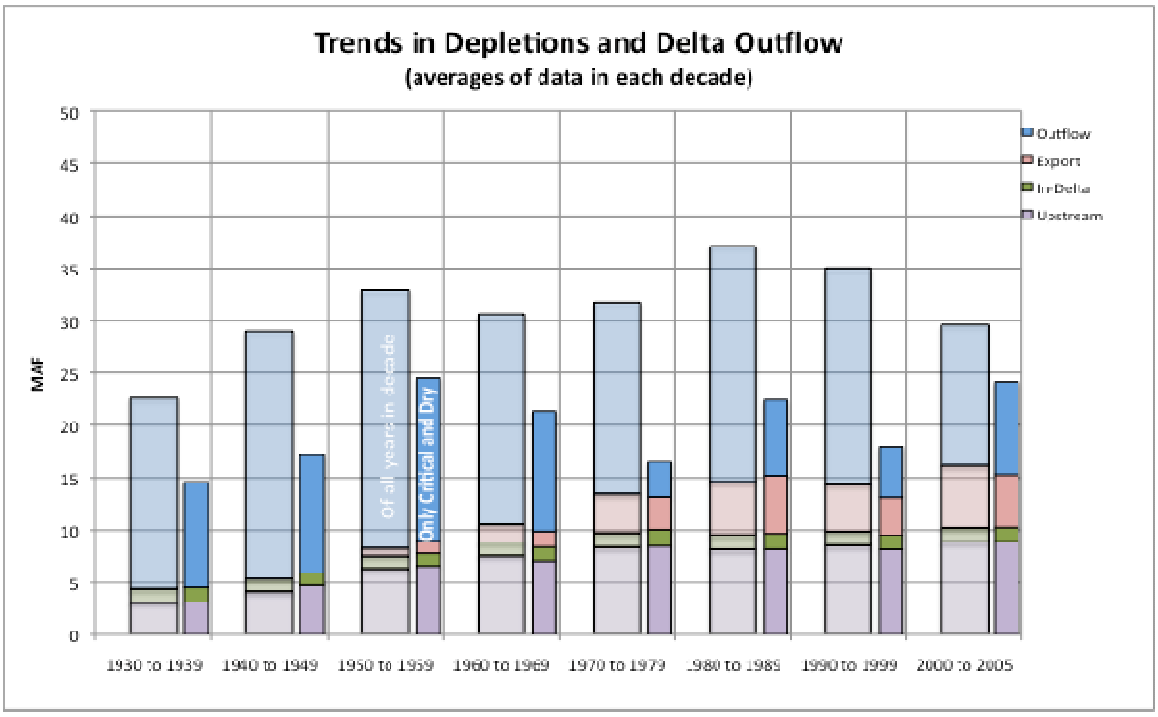
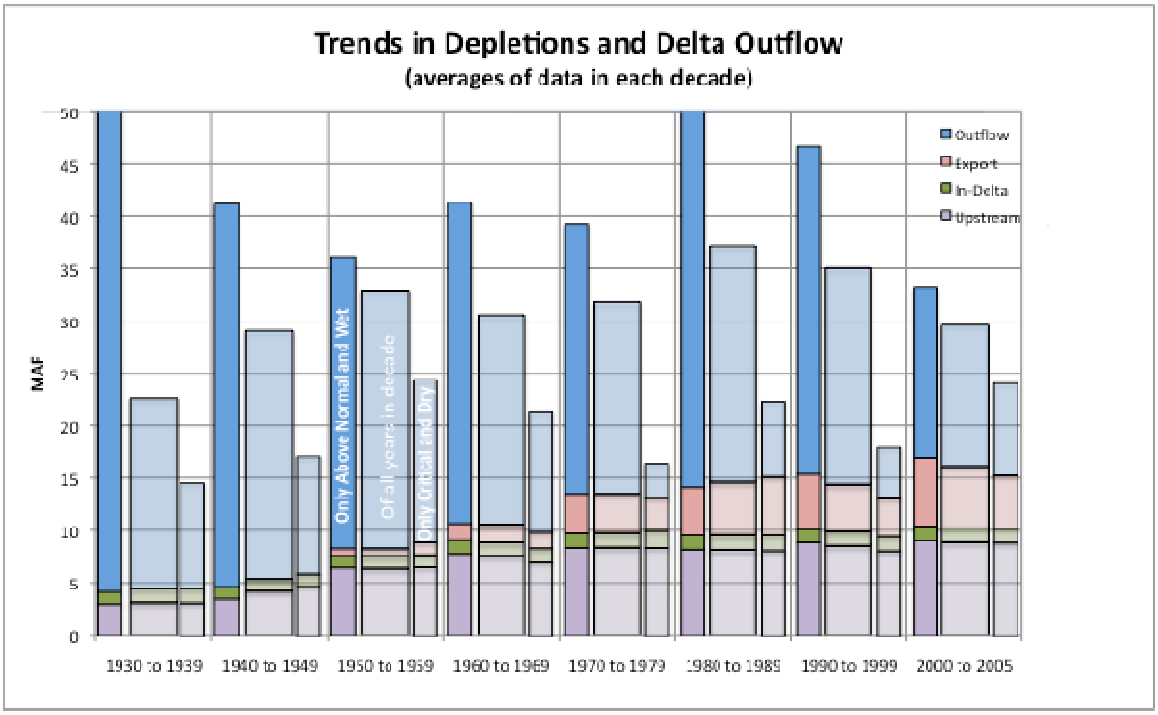
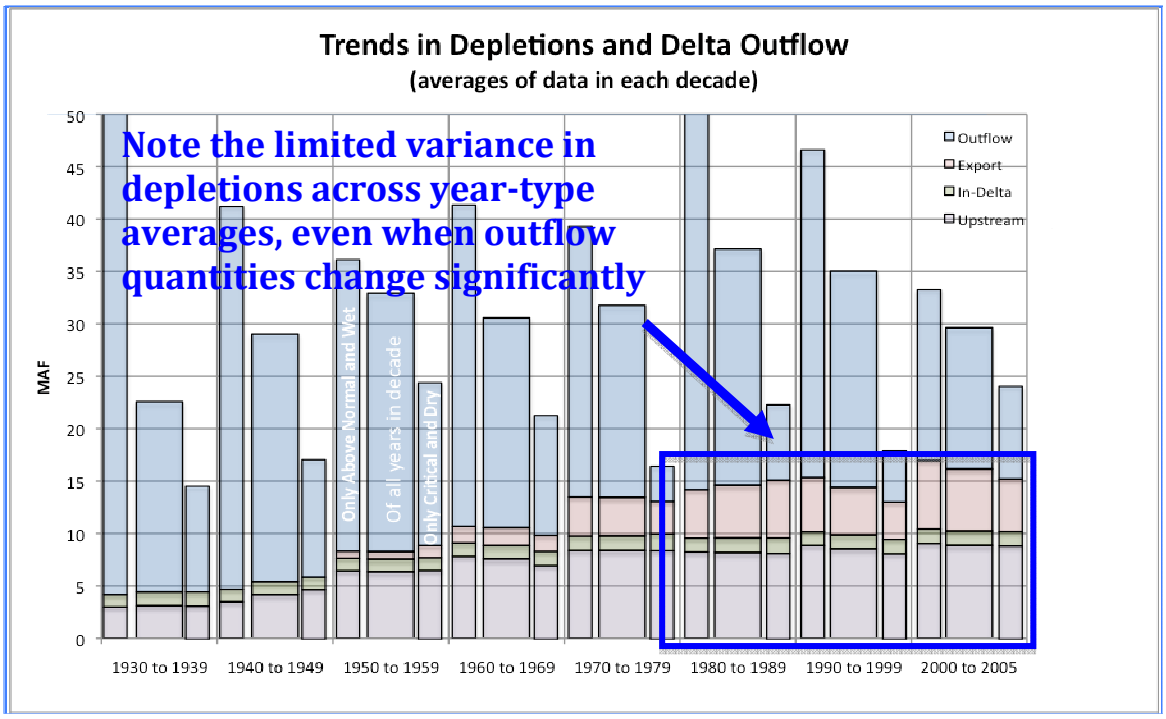


Figure 4 – Averages for "Above Normal and Wet" Year-type compared to "All" and "Critical and Dry"



Highlighting the averaged values for the last few decades (see the framed box in **Figure 5**), a comparison can be made of the total depletions– Exports, Upstream, and In-Delta – in each of the three year-type averages. What is most notable is that even with dramatic variance in outflow, especially when comparing "Wet and Above Normal" columns to the "Dry and Critical" columns, there is nominal variance in the total stacked quantity that represents total depletions.

Figure 5 – Limited Variances in total depletions under different year-type averages



Focus on Freshwater Outflow

One way to look at the historical change to Delta freshwater outflow is to compare the percentage of the annual total water available that is outflow compared to the total depletions. As described earlier, the "total water" available is the sum of all four data categories – outflow plus the three depletion categories.

Figure 6 presents the average outflow value calculated for each decade. The area below the line represents the percentage of the total water available that was outflow (as an average value from all ten years within that decade). For instance, in the 1930's approximately 80% of the total water on average went toward freshwater outflow. In the 1980's and 1990's the value has declined to about 60%.

The remaining percentage (or area above the line) constitutes the water that served the three depletion categories. In the 1930's that component represented about 20% of the total water. In the 1980's and 1990's the percentage increased to about 40%. In the most recent 5 year period reflected by the available data (2000 through 2005), the depletion percentage has increased on average to over 50% of the total water available.

To further illustrate this declining trend, **Figure 7** includes the percent of outflow for the "Wet and Above Normal," "Above Normal and Below Normal," and the "Dry and Critical" averages for each decade period.

The downward trends in the average percentages for all but the "Dry and Critical" values are fairly consistent across the decades. However, the "Dry and Critical" period has a greater degree of decline, with a significant decrease occurring in the 1970's with only limited recovery in the past 6-year data set. [*Note: the increased outflow percentage of the past 6 years is likely influenced by a greater total water availability over the period due to three above normal years and only two dry years, compared to five "Critical" years in the 1990's and a combination of five "Critical" and "Dry" years in the 1980's.*]

As illustrated in the Figures, the data indicates that conditions in recent decades have become reversed as compared with conditions before approximately 1950 – especially in "Critical" and "Dry" years. Previously at least 60% of total water went to freshwater outflow, wherease less than 50% and as low as 30% to 40% has gone to outflow in recent decades.

While natural hydrology may be a minor contributor to the observed trends, it is clear that the dominant factor is the progressive increase in total depletions since the middle of the 1900s.

Figure 6 – Average percentage of total water occurring as Delta freshwater outflow for all years within each decade period

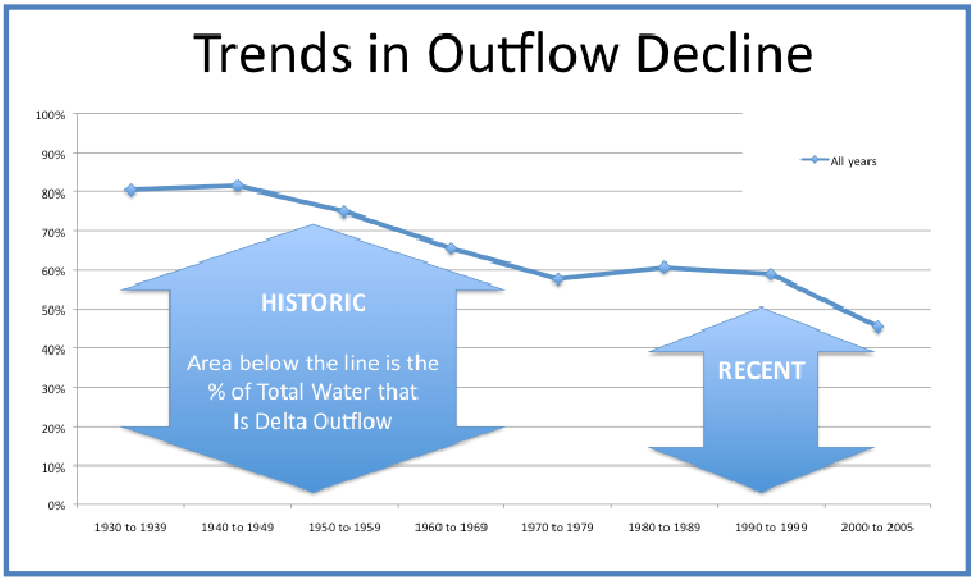


Figure 7 – Average percentage of total water occurring as Delta freshwater outflow for other year-type subgroupings