Delta smelt and their food

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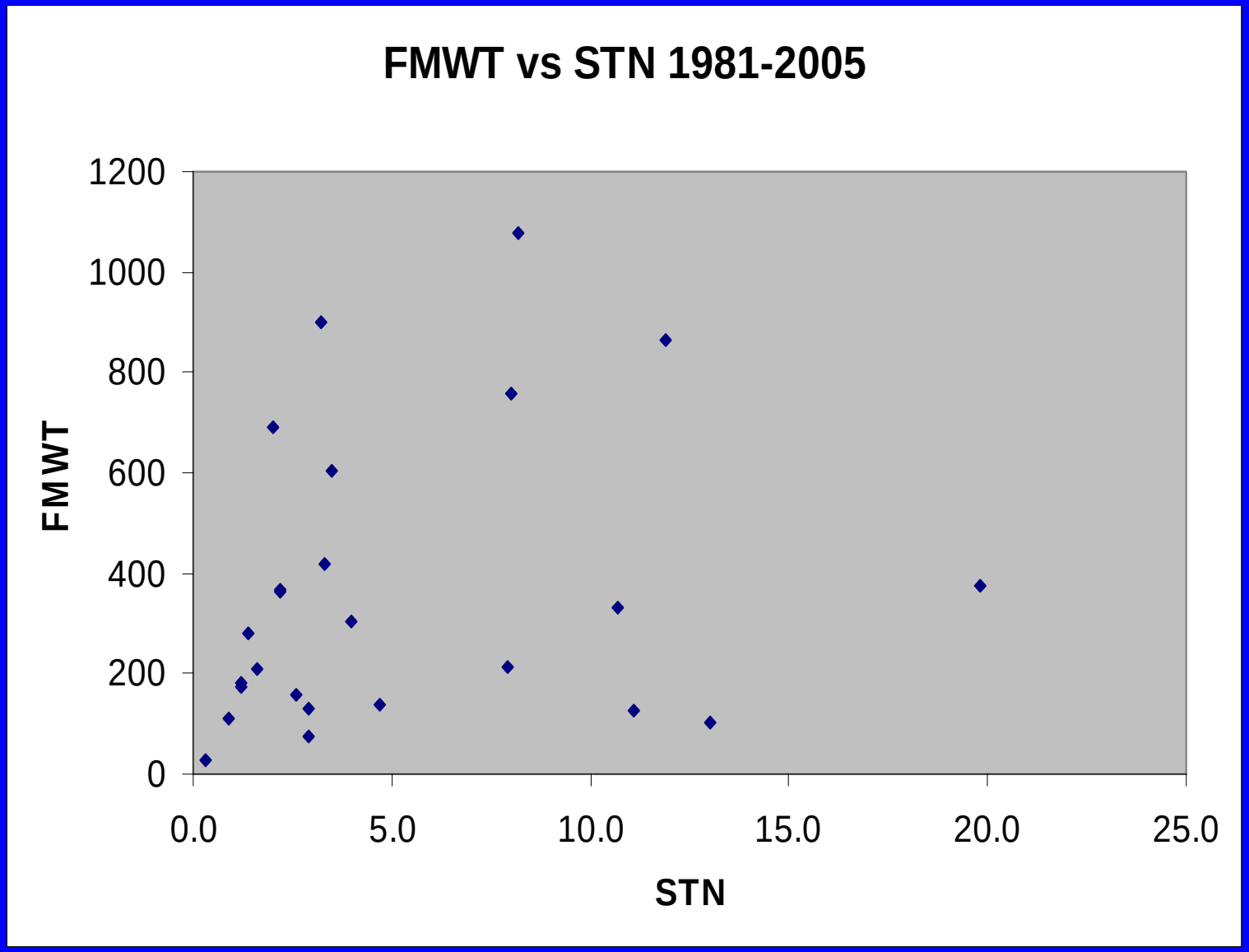
FMWT strongly correlates with July smelt and prey co-occurrence at Sacramento-San Joaquin confluence and downstream into Suisun Bay

- Low delta smelt abundance in last quarter century
- No linear correlation between STN and FMWT
- Indicates lack of juveniles does not control FMWT


FMWT vs STN 1981-2005
1200
1000
800
600
400
200
0
FMWT
0.0
5.0
10.0
15.0
20.0
25.0
STN

- Bennett and Teh (UCD) found smelt malnourishment in late summer
- Suggests food availability affects FMWT

- B. J. Miller analyzed July STN and zooplankton data
- Found strong correlations between FMWT and July smelt/prey co-occurrence in core delta smelt habitat at Sacramento-San Joaquin confluence and downstream into Suisun Bay

Please repeat this analysis yourself to verify what publicly available data tell us about delta smelt FWMT abundance

Required data

- **Fall Midwater Trawl Index:**

  http://www.delta.dfg.ca.gov/data/mwt/charts.asp

- **Summer TowNet data:**

  Townet_Data.zip from DFG password-protected FTP site. Marade Bryant (mbryant@deltaq.dfg,ca.gov) has instructions

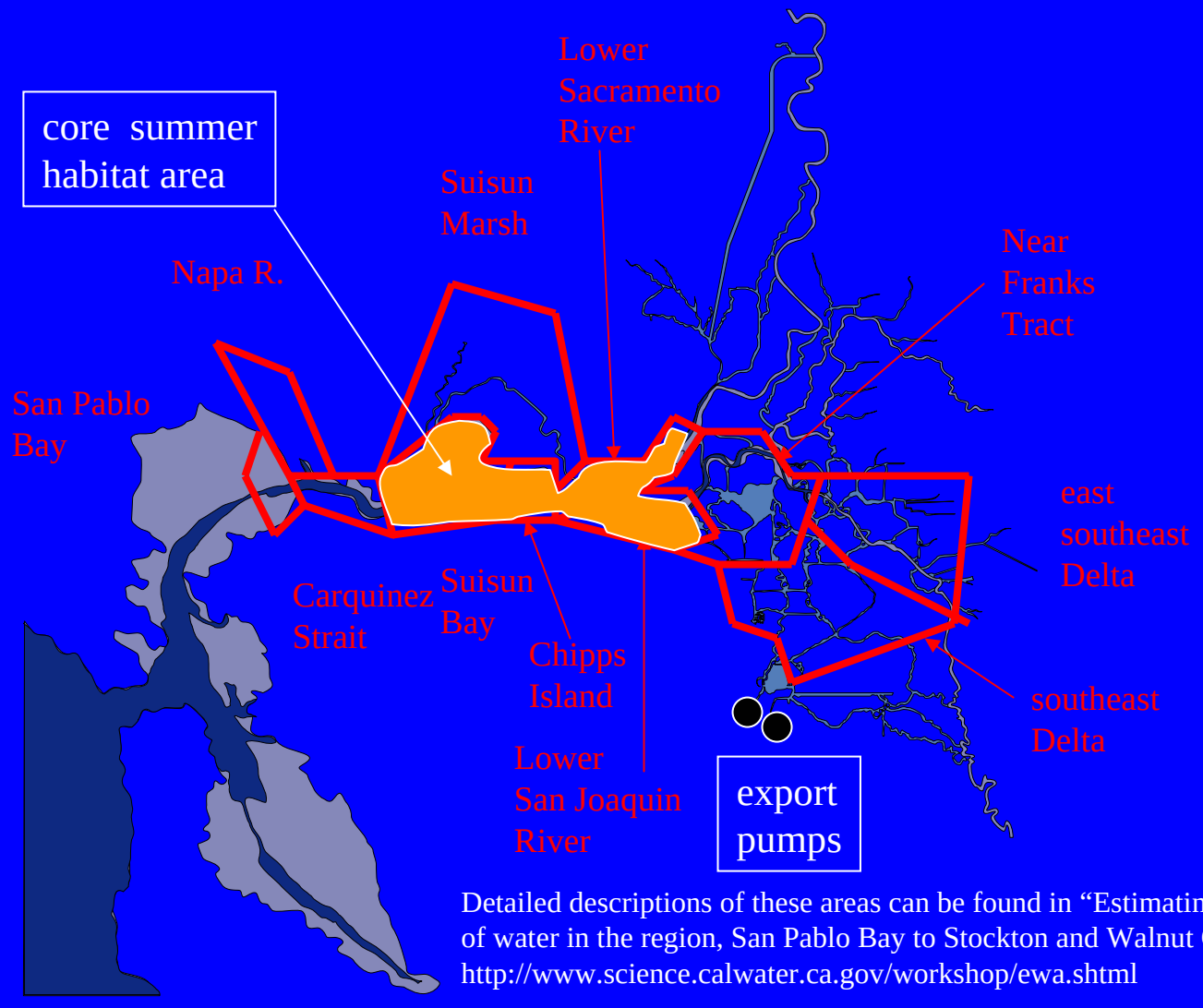
- **Zooplankton data:**

  DFG file reworked by Kathy Heib (khieb@delta.dfg.ca.gov)

Data summaries

- Alison Britton (asbritton@aol.com) resolved data difficulties and can send complete set
- Simple spreadsheet with data and all calculations available from tmongan@mail.com

co-occurrence areas



Detailed descriptions of these areas can be found in "Estimating area and volumes of water in the region, San Pablo Bay to Stockton and Walnut Grove," Miller WJ, http://www.science.calwater.ca.gov/workshop/ewa.shtml

volumes of co-occurrence areas

area	San Pablo	Napa River	Carquin-ez Strait	Suisun Marsh	Suisun Bay	Chipps Island	Lower Sacra-mento River	Lower San Joaquin River	near Franks Tract	east-south-east Delta	south-east Delta
volume, $m^3 x10^6$	390.5	59.4	262.8	93.2	362.3	125.6	186.5	134.3	243.0	94.5	89.3

Correspondence of co-occurrence areas and Summer Tow Net (STN) and Zooplankton Survey stations.

Area	San Pablo Bay	Napa River	Carquin-ez Strait	Suisun Marsh	Suisun Bay	Chipps Island	lower Sacra-mento River	lower San Joaquin River	near Franks Tract	south-east Delta	east south-east Delta
					summer core habitat area						
Summer Tow Net (STN) Survey stations	323 328 329 336	340	405	606 609 610	411 418 501 505 602	508 513 519 520	704 706 707	801 804 809	812 815 902	914 915 918	906 910 912 919
Zooplankton Survey stations	NZ300 NZ305 NZ310 NZ325 NZD41	340	NZ002 NZ003 NZ004 NZ005 NZ338	NZ032 NZ033 NZ034 NZS42	NZ020 NZ022 NZ024 NZ028 NZ030 NZ036 NZ038 NZ042 NZ044 NZ046 NZ048 NZ41A NZD06	NZ040 NZ050 NZ052 NZ054 NZ056 NZ058	NZ060 NZ062 NZ064 NZ066 NZ068 NZ070	NZ072 NZ074 NZ076 NZ078 NZD11 NZD14	NZ080 NZ082 NZ084 NZ086 NZ088 NZD15 NZD16 NZD19	NZ098 NZD28 NZP10	NZ090 NZ092 NZM04 NZM08 NZM10

- Gear efficiencies unknown, so STN and zooplankton data represent relative densities
- Focus on core habitat – 95% of smelt are there in July

- Assume primary food of delta smelt is *Eurytemora affinis* and *Pseudodiaptomus forbesii*
- Sum average densities of these species in each sub-area to estimate prey density

July smelt abundance and survival

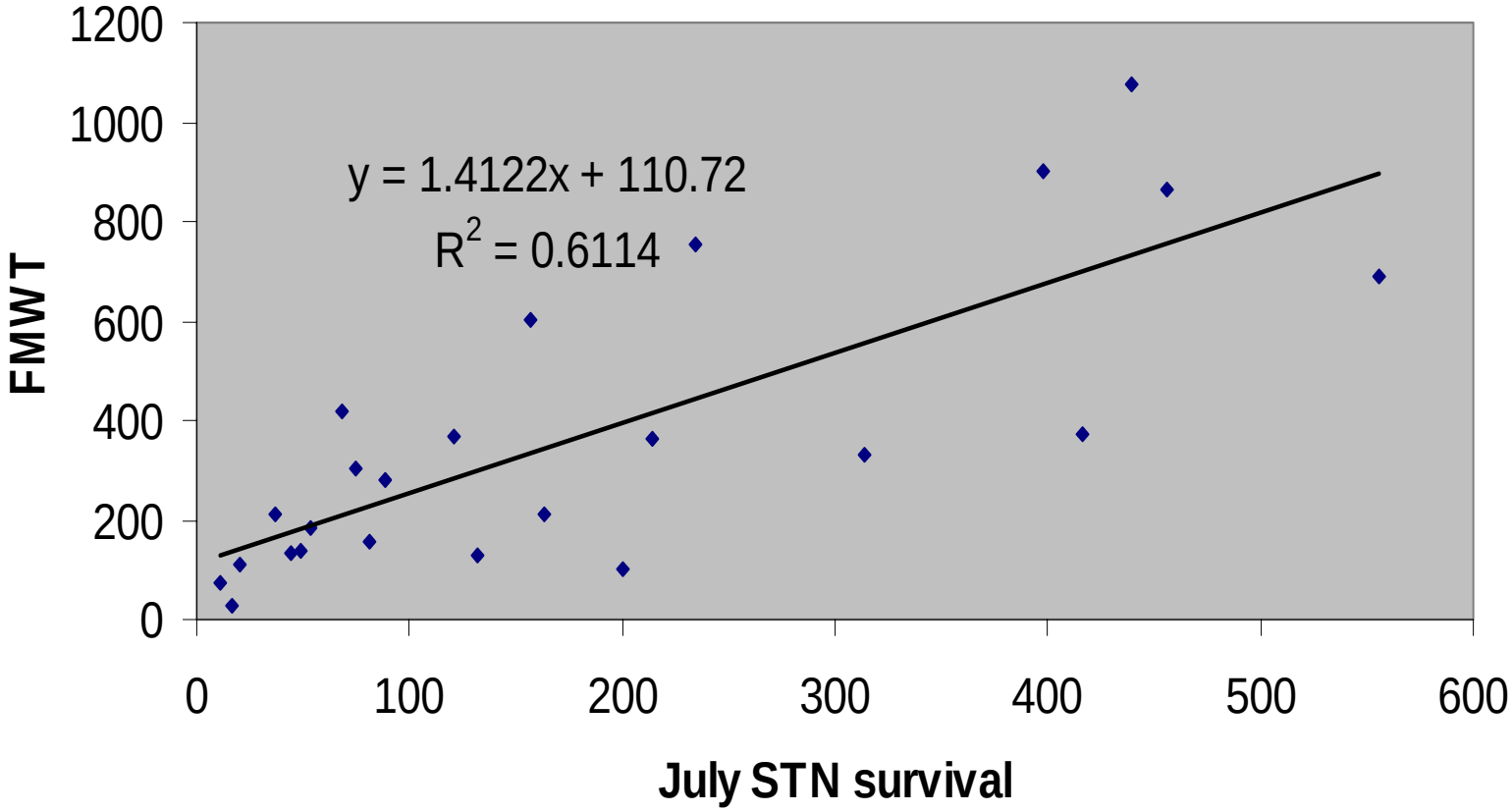
- Relative July smelt abundance in each sub-area estimated as (relative smelt density) x (sub-area volume)
- Estimate July delta smelt survival in core habitat sub-areas in two ways

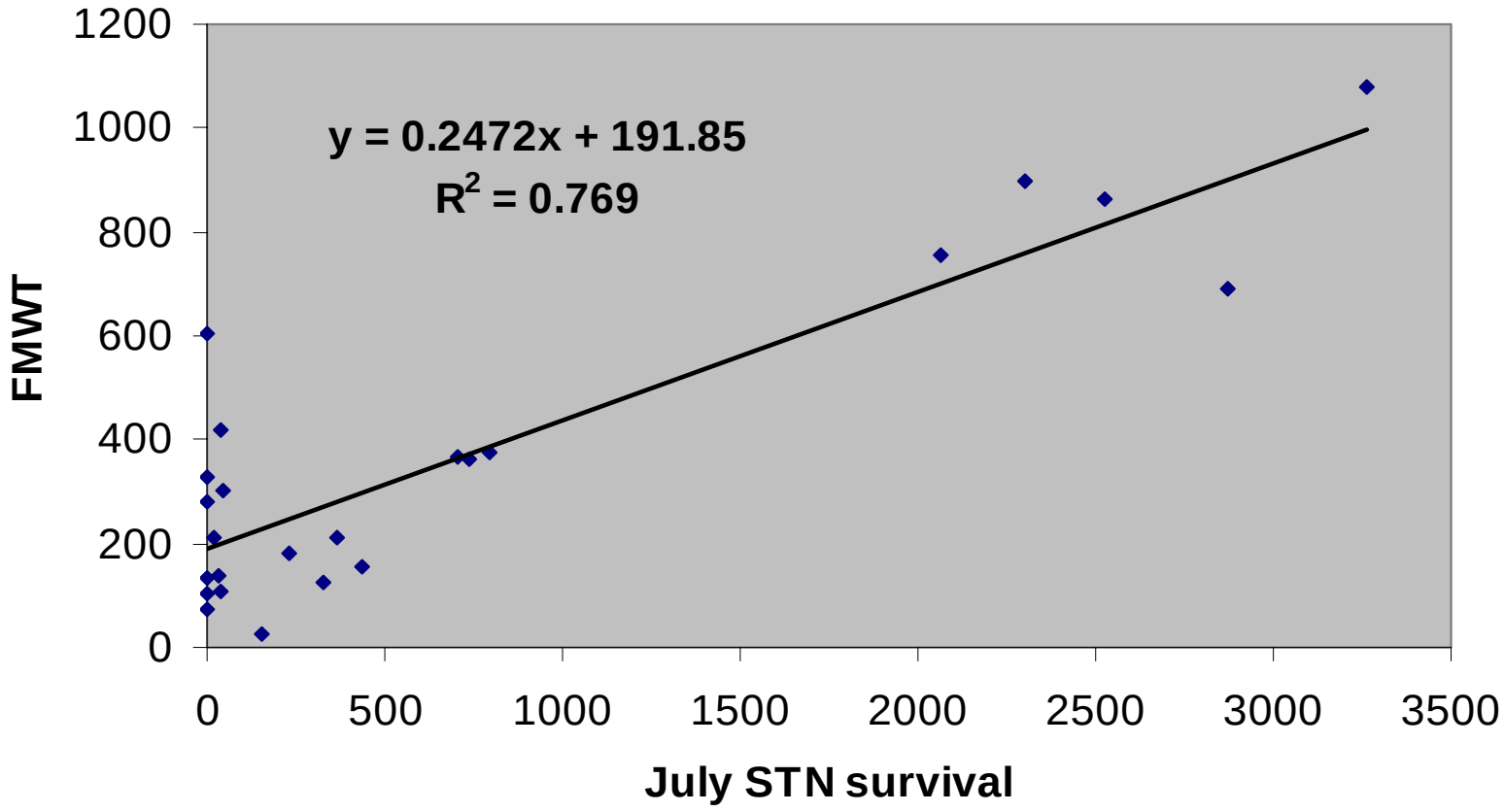
Linear survival estimate

- Assume survival proportional to prey density = assuming smelt never encounter excess food
- Implies same number of survivors (on average) when many juveniles compete for sparse food as when few juveniles encounter much food

Threshold survival estimate

- Smelt stressed with average 1981-2005 core habitat prey density near 1,250/m^3
- Assume no smelt survive in sub-areas with average prey density < 1,250/m^3, all survive in sub-areas with higher prey density
- Assumes smelt only find subsistence rations, on average, when prey density > 1,250/m^3


1981-2005 FMWT vs July STN
linear survival, p = 0.000006
y = 1.4122x + 110.72
R2 = 0.6114
FMWT
July STN survival
0
200
400
600
800
1000
1200
0
100
200
300
400
500
600

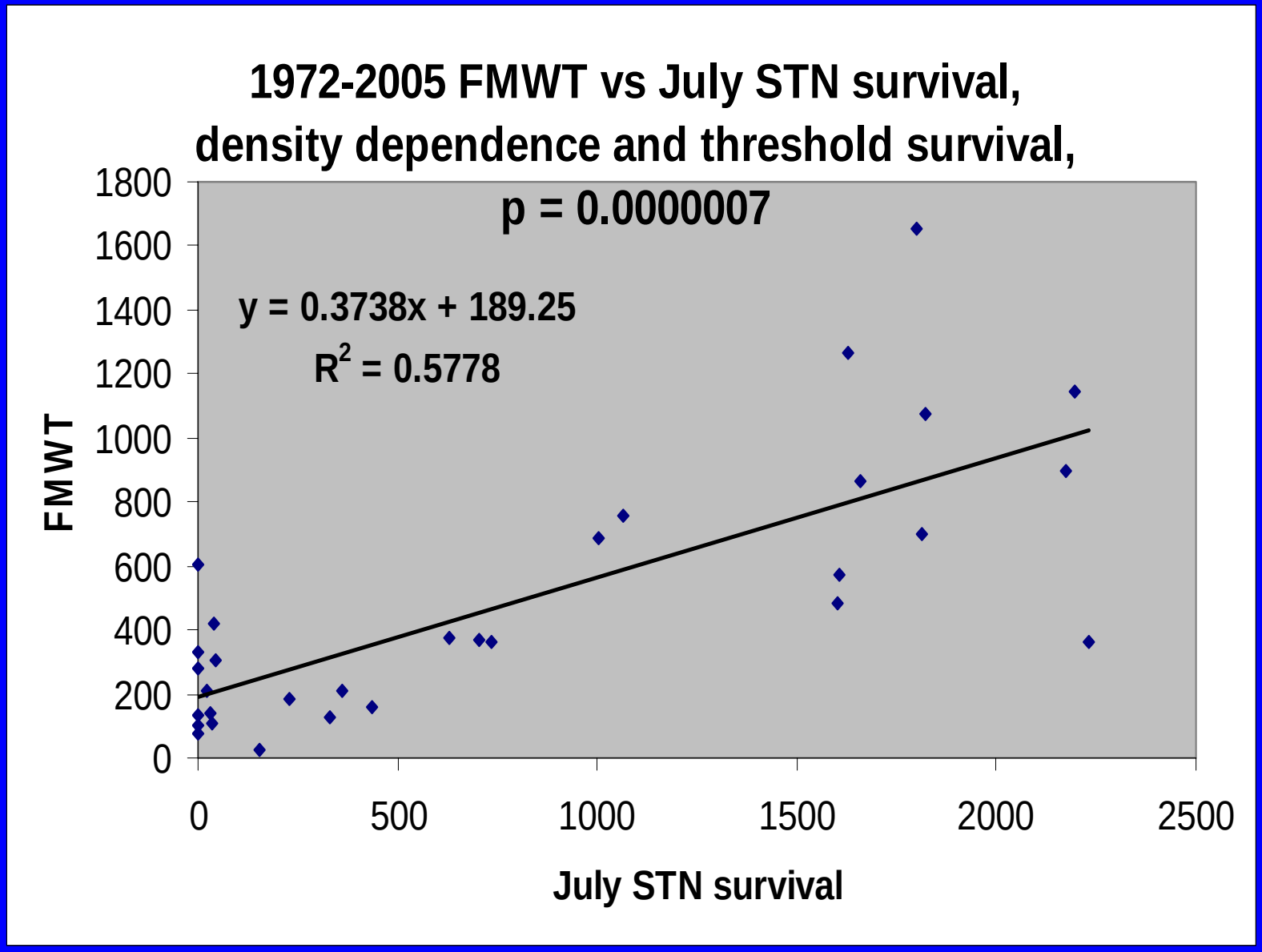

1981-2005 FMWT vs July STN threshold survival, p = 0.00000002
y = 0.2472x + 191.85
R2 = 0.769
FMWT
July STN survival
0
200
400
600
800
1000
1200
0
500
1000
1500
2000
2500
3000
3500

Density dependence to extend to 1972 - 2005

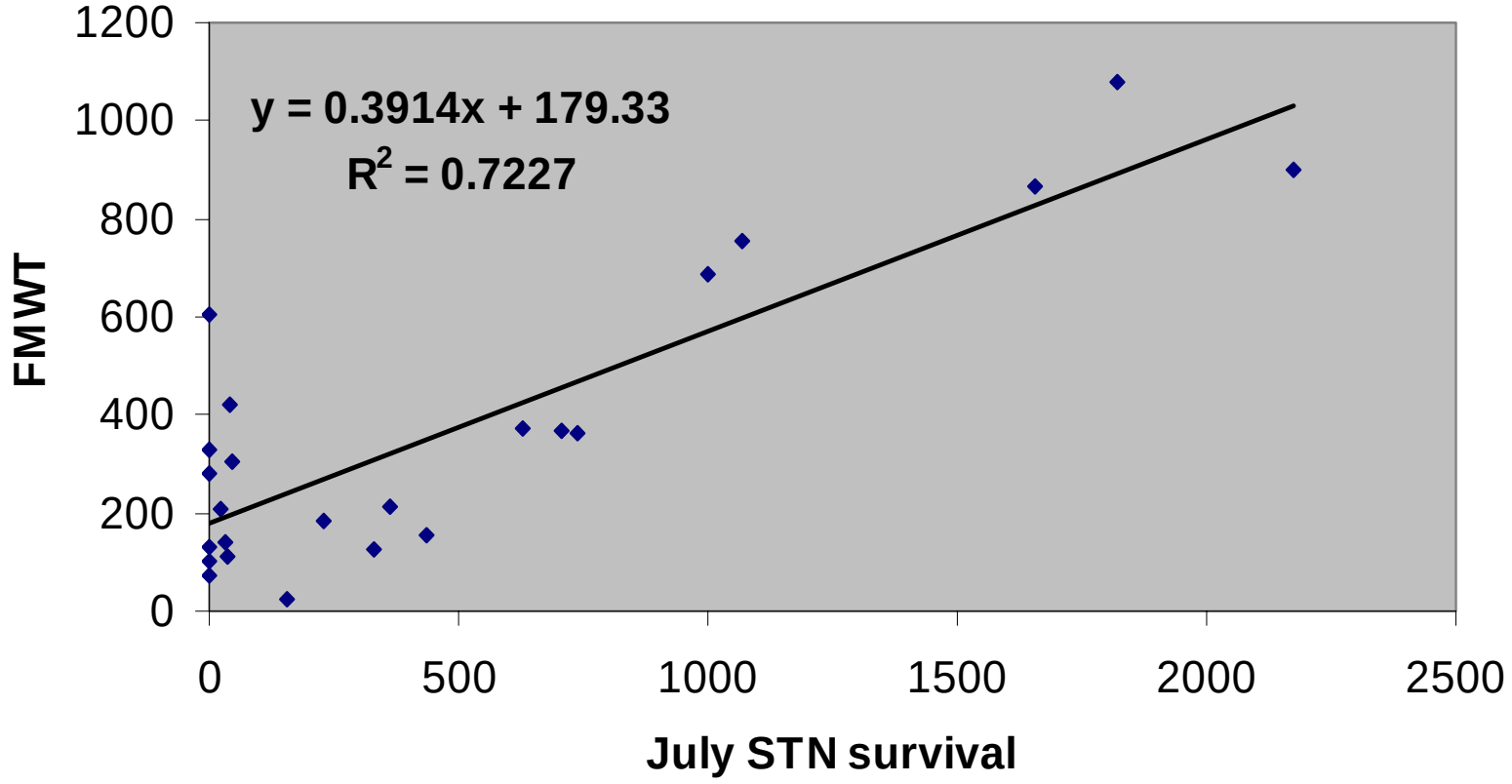
- Average July 1972 – 2005 core habitat relative delta smelt density = $5/m^3$
- Before 1981, relative smelt density in lower Sacramento River > $100/m^3$ in several years when FMWT not proportionally high
- Suggests density dependence

Density dependence

- Approximated density dependence by limiting July smelt survival in each sub-area to $5/m^3$
- Worked for threshold survival, but not linear survival


1972-2005 FMWT vs July STN survival,
density dependence and threshold survival,
p = 0.0000007
y = 0.3738x + 189.25
R2 = 0.5778
FMWT
1800
1600
1400
1200
1000
800
600
400
200
0
0
500
1000
1500
2000
2500
July STN survival

1981-2005 FMWT vs July STN survival, density dependence and threshold survival p =0.0000002



Additional co-occurrence analyses

- Including all sub-areas of Delta does not change results – nearly all smelt are in core habitat in July
- Including *Tortanus* and *Limnoithona* in prey density does not improve results

Export effects on FMWT?

- Chotkowski directed Manly in exhaustive search for effects
- Manly found *statistically significant but not important* effects

Export effects on FMWT when smelt close to pumps?

- Miller and Manly did exhaustive analyses looking for effects in years when surveys indicated juveniles or adults might be near pumps

“Close to pumps” results

- No important correlations between export pumping and FMWT, even in years when data indicate adult and juvenile smelt are near pumps
- Analyses available from bj_miller@sbcglobal.net
- Now under review

Implication of co-occurrence

- Crucial FMWT index largely controlled by summer availability of zooplankton prey in core habitat > 30 miles from export pumps, at Sacramento-San Joaquin confluence and downstream into Suisun Bay

Consequences

- If we really want to help delta smelt, we must focus on summer food availability in core habitat
- That might be affected by alien invaders, toxics, or even power plant entrainment
- It’s unlikely to be affected by export pumping more than 30 miles from the core habitat