

Appendix 4: Fate and Age Exposure Time Maps for high-flow conditions, June 2011

in Delta RMP Nutrients Synthesis: Modeling to Assist Identification of Temporal and Spatial Data Gaps for Nutrient Monitoring

Fate and Age/Exposure Time Maps

- Simulation time span: June 01, 2011 00:15 to June 28, 2011 23:45
 - RMA Logo can be ungrouped and moved if needed
 - NOTE – the velocity file for the June 2011 simulations was sourced from the calibration modeling from 2015.
- 50 particles inserted near inflow locations every 15 min. during the simulation
 - Particles inserted in Sacramento, Yolo+Lisbon, San Joaquin, Mokelumne, Cosumnes sources
 - Yolo+Lisbon inserted near Lisbon Toe Drain
 - Calaveras not considered as a source (flows too low during simulation period)
- Age/Exposure time tracked in entire Delta and in all relevant regions
- The final two slides show the Central Region split into Upper and Lower Regions as Fate Maps
- For region+sources where either few or no particles reach a region, the statistics are not recorded for that source
 - Statistics are documented in this file
 - In some cases, tidal interactions are highlighted in figures

Fate and Age/Exposure Time Maps

- Age/Exposure time:
 - Particle count is independent of flow rate – all sources therefore treated similarly for particle count calculations in regions
 - Particles may be removed from simulation once they reach Martinez
 - Exposure time allows multiple entries/exits from the region
 - Exposure time and Age statistics are calculated for particles that have entered or left (*i.e.*, been exposed to) the region by simulation end on June 28th
- Fate Maps – two parameters are set:
 - # of particles specified for insertion was 100,000 or 150,000, fewer for smaller regions or where less information needed (e.g. – high flow rate)
 - actual number inserted will be lower, table of results gives actual particle count
 - Cell size for insertions set at either 50 or 100 by examination of Fate Map output, for the most visually understandable results
 - In a few regions including model boundaries, the computational region was modified slightly from the region used for Age and Exposure time calculations

This is the High flow period of analysis

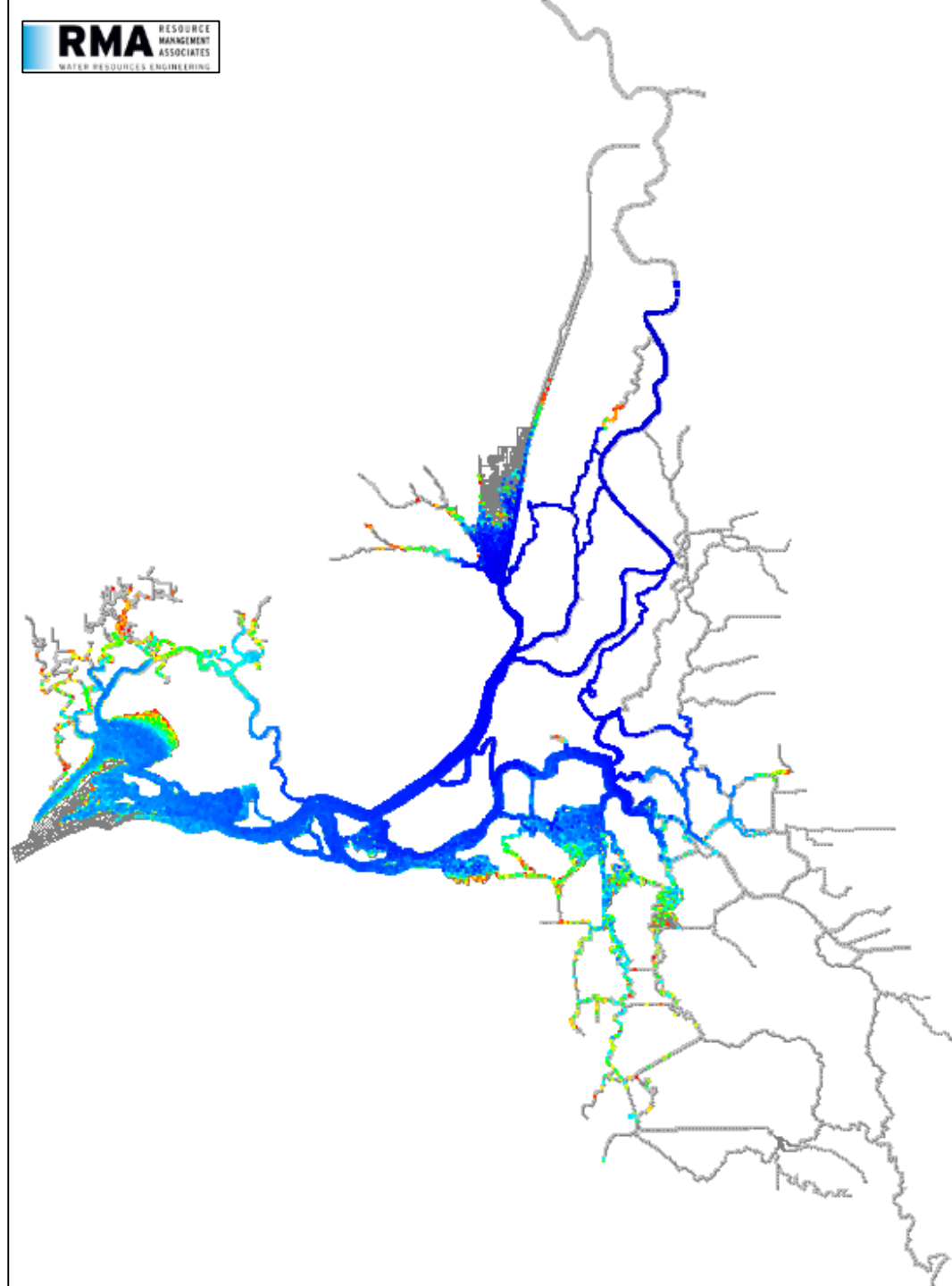
	Flow Type	SJR	SAC R.	CVP+SWP	CALAVERAS	COSUMNES	MOKELUMNE	YOLO+LIS
June, 2011	High	10529	41397	9676	103	947	1786	655
Sept., 2010	Average	1713	16451	10403	21	13	163	158
Sept., 2008	Low	801	10461	4930	32	3	33	110

Structures – Gate and Barrier Positions

	Delta Cross Channel	Head Old River Barrier	Old River Barrier	Middle River Barrier	Grant Line Barrier	
September 2008	Open	Open	Closed	Closed	Closed	
September 2010	Open	Open	Closed	Closed	Closed	
June 2011	Closed	Open	Closed part mo.	Closed part mo.	Closed	

June 28, 2011 23:45
Sacramento Source
134,300 Particles Inserted
Age in Full Delta

Color Scale Indicates Approximate Age



June 28, 2011 23:45

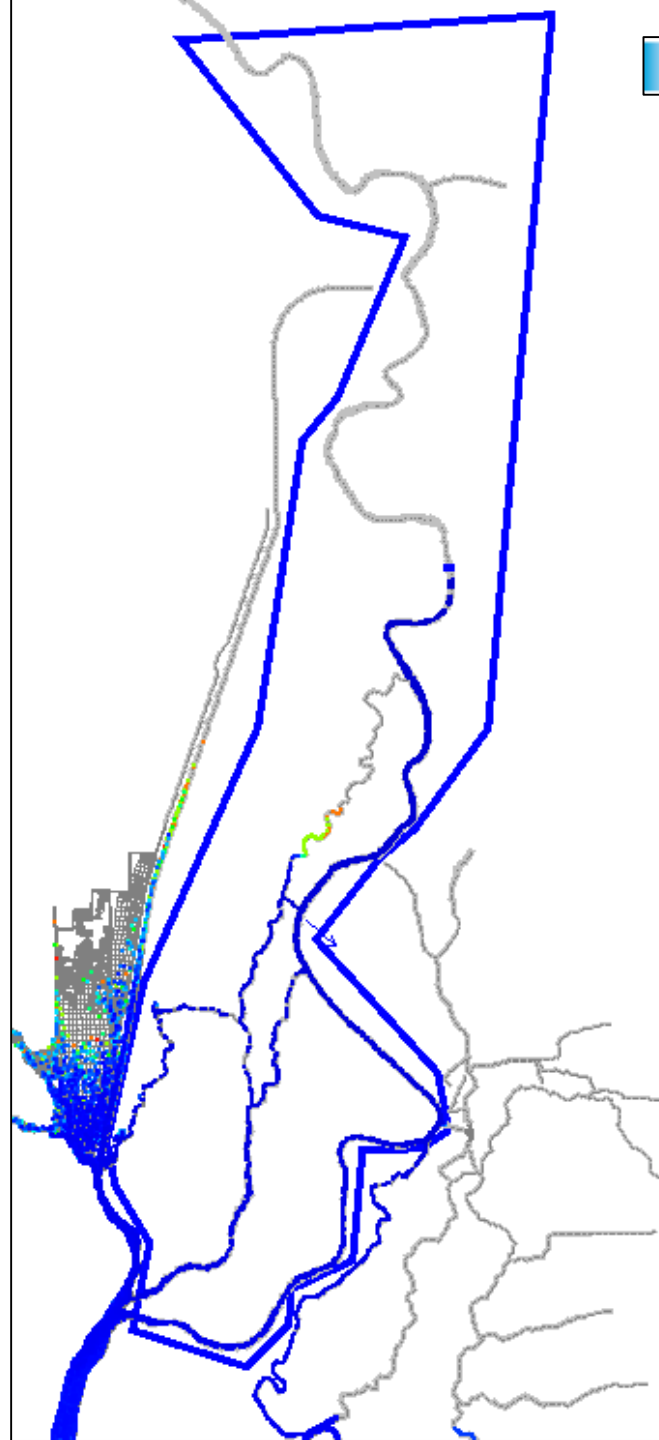
Sac Source

Age in Sacramento R. Region

134,300 Particles Inserted

Statistics not calculated

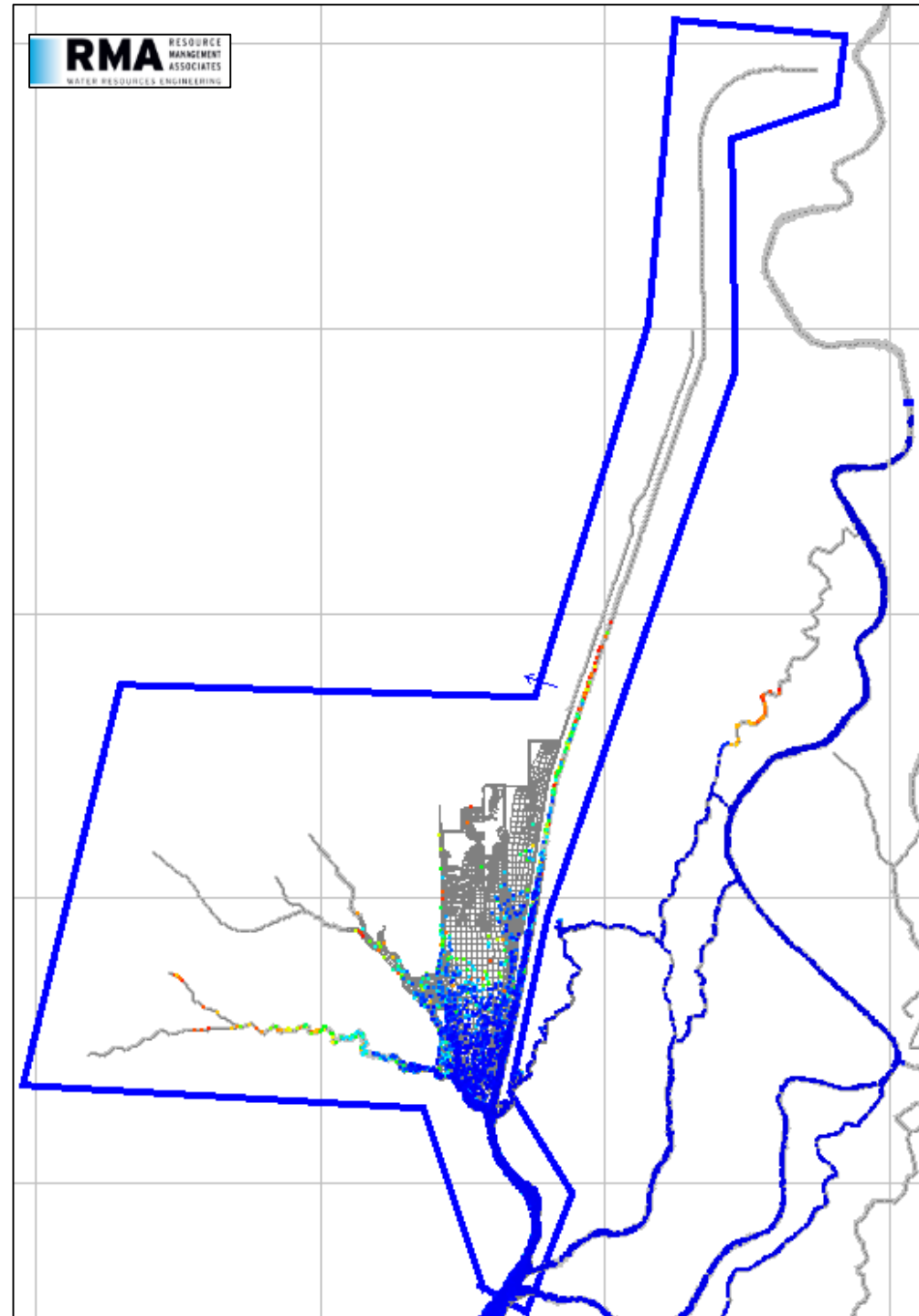
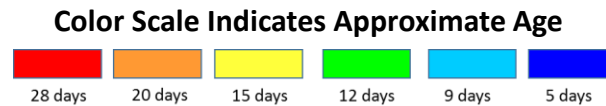
Color Scale Indicates Approximate Age



June 28, 2011 23:45
 Sac Source
 Age in N. Delta Region
 134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	98.4%	99.9%
5 to 10	1.3%	0.1%
10 to 15	0.2%	0.0%
15 to 20	0.0%	0.0%
20 to 25	0.0%	0.0%
25 to 28	0.0%	0.0%

	Count	Regional %	% of Total
Particles Entering	91233	100%	67.9%
Particles Staying	87350	95.7%	65.0%
Particles Leaving	3883	4.3%	2.9%



June 28, 2011 23:45
Sac Source
Age in Eastside Region

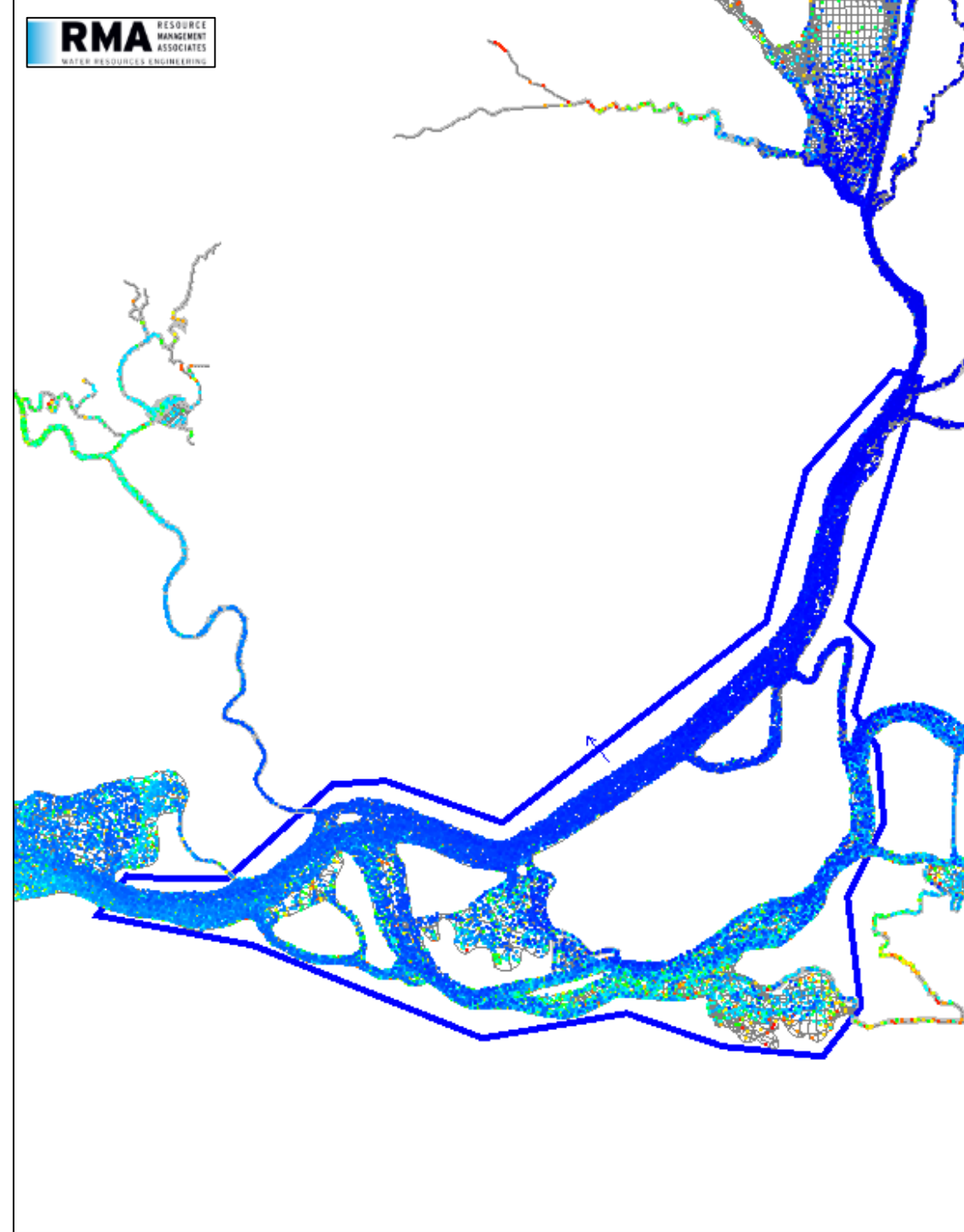
DCC is closed, so no Sac particles in Eastside Region

June 28, 2011 23:45
Sac Source
Age in Confluence Region
134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	50%	84%
5 to 10	35%	14%
10 to 15	10%	2%
15 to 20	4%	1%
20 to 25	1%	0%
25 to 28	0%	0%

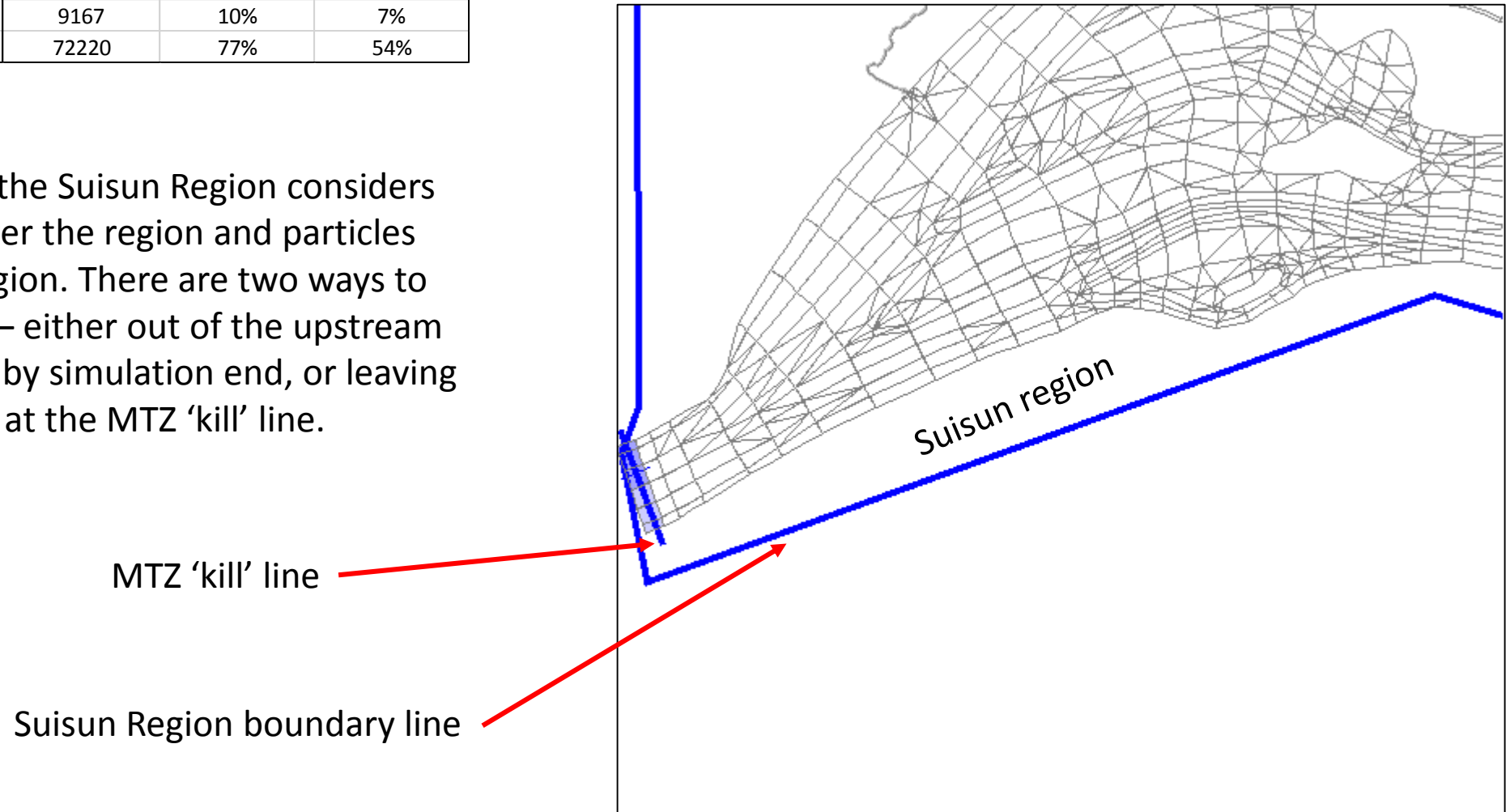
	Count	Regional %	% of Total
Particles Entering	107725	100%	80%
Particles Staying	83890	78%	62%
Particles Leaving	23835	22%	18%

Color Scale Indicates Approximate Age



	Count	Regional %	% of Total
Particles Entering	93829	100%	70%
Particles Exiting Upstream	9167	10%	7%
Particles Exiting MTZ	72220	77%	54%

Particle count in the Suisun Region considers particles that enter the region and particles that leave the region. There are two ways to leave the region – either out of the upstream region boundary by simulation end, or leaving the computation at the MTZ ‘kill’ line.

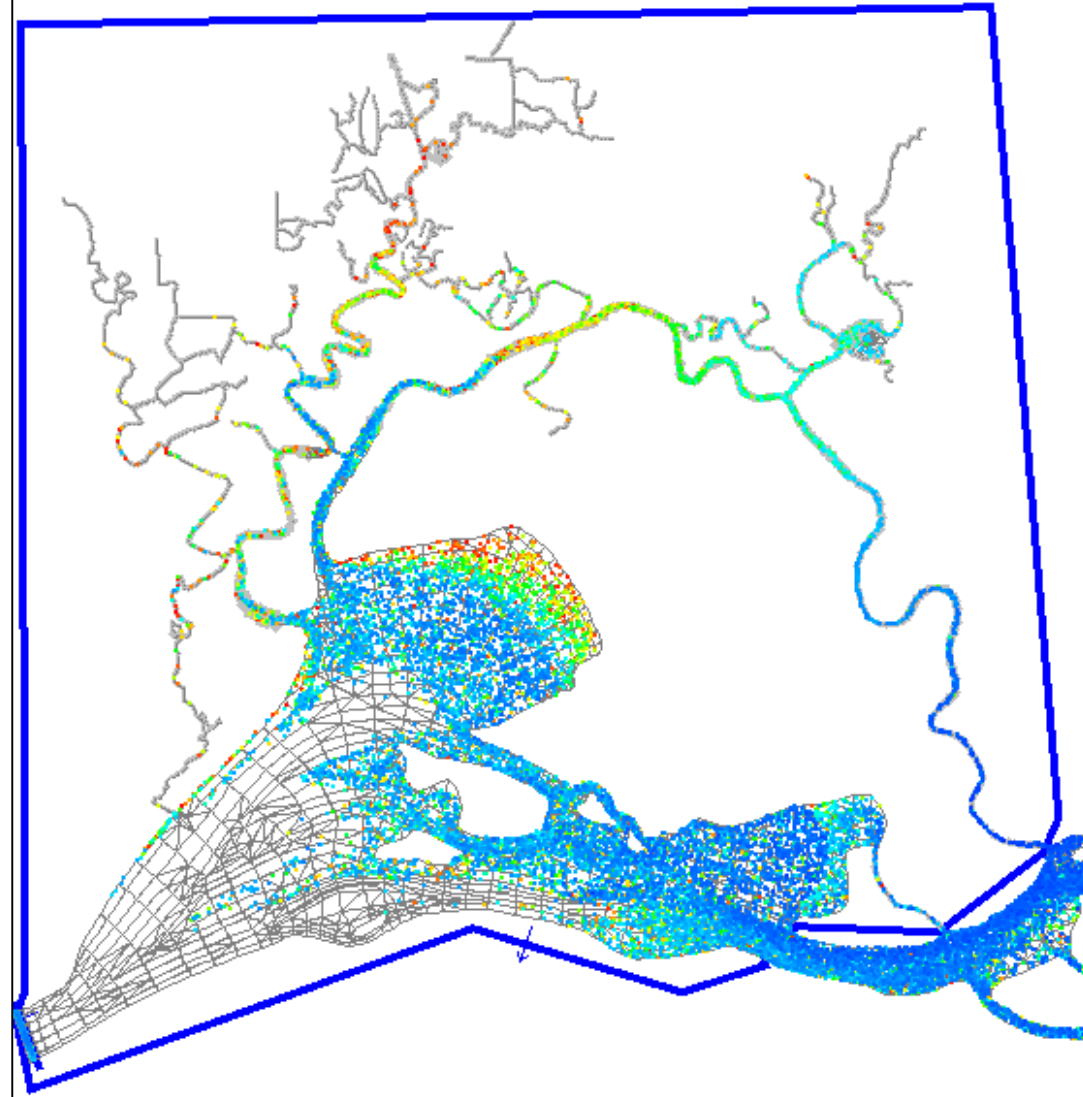


June 28, 2011 23:45
Sac Source
Age in Suisun Region
134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	44%	63%
5 to 10	39%	24%
10 to 15	10%	9%
15 to 20	5%	4%
20 to 25	1%	1%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	93829	100%	70%
Particles Exiting Upstream	9167	10%	7%
Particles Exiting MTZ	72220	77%	54%

Color Scale Indicates Approximate Age

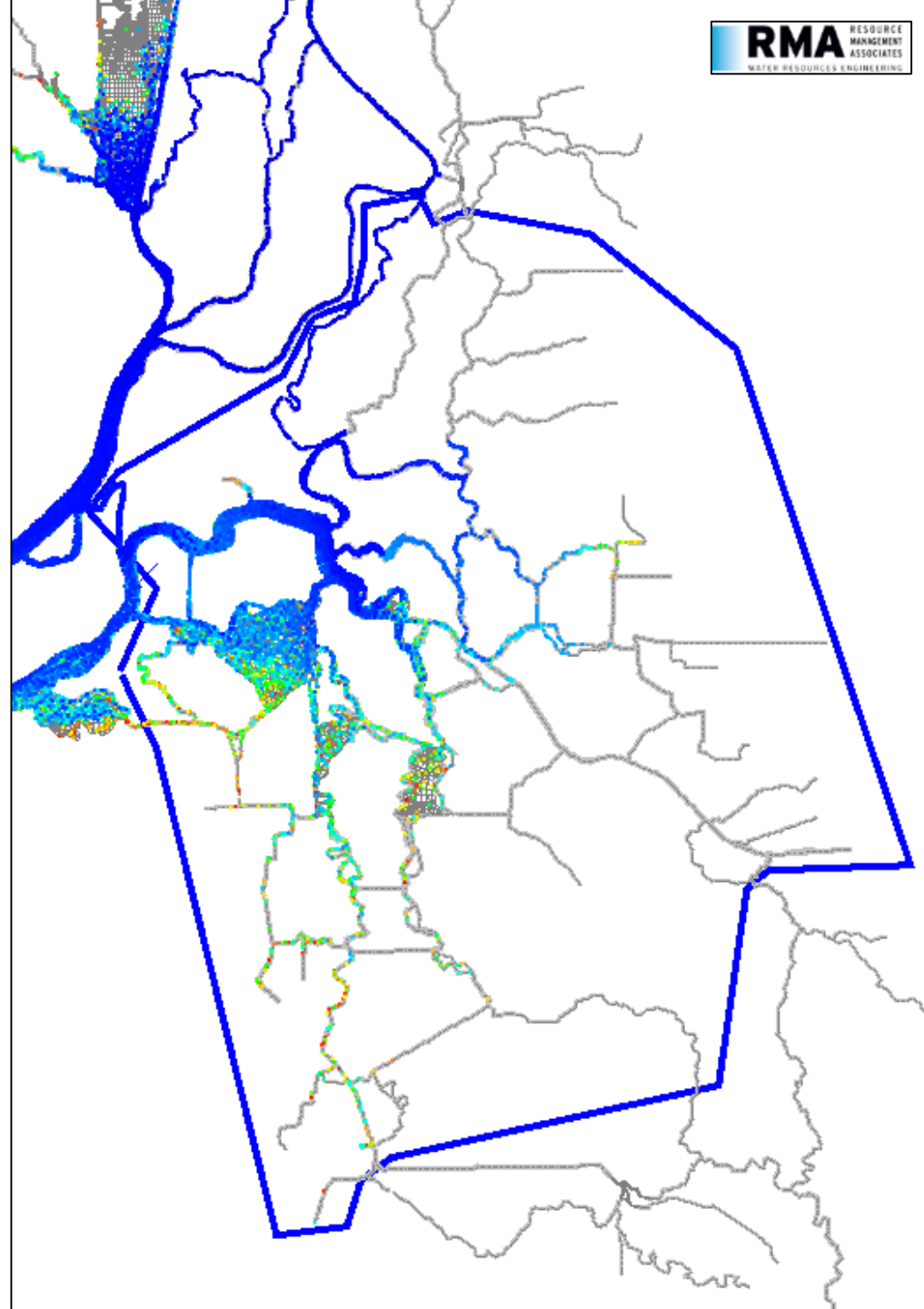


June 28, 2011 23:45
 Sac Source
 Age in Central Region
 134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	57%	98%
5 to 10	31%	2%
10 to 15	10%	0%
15 to 20	2%	0%
20 to 25	0%	0%
25 to 28	0%	0%

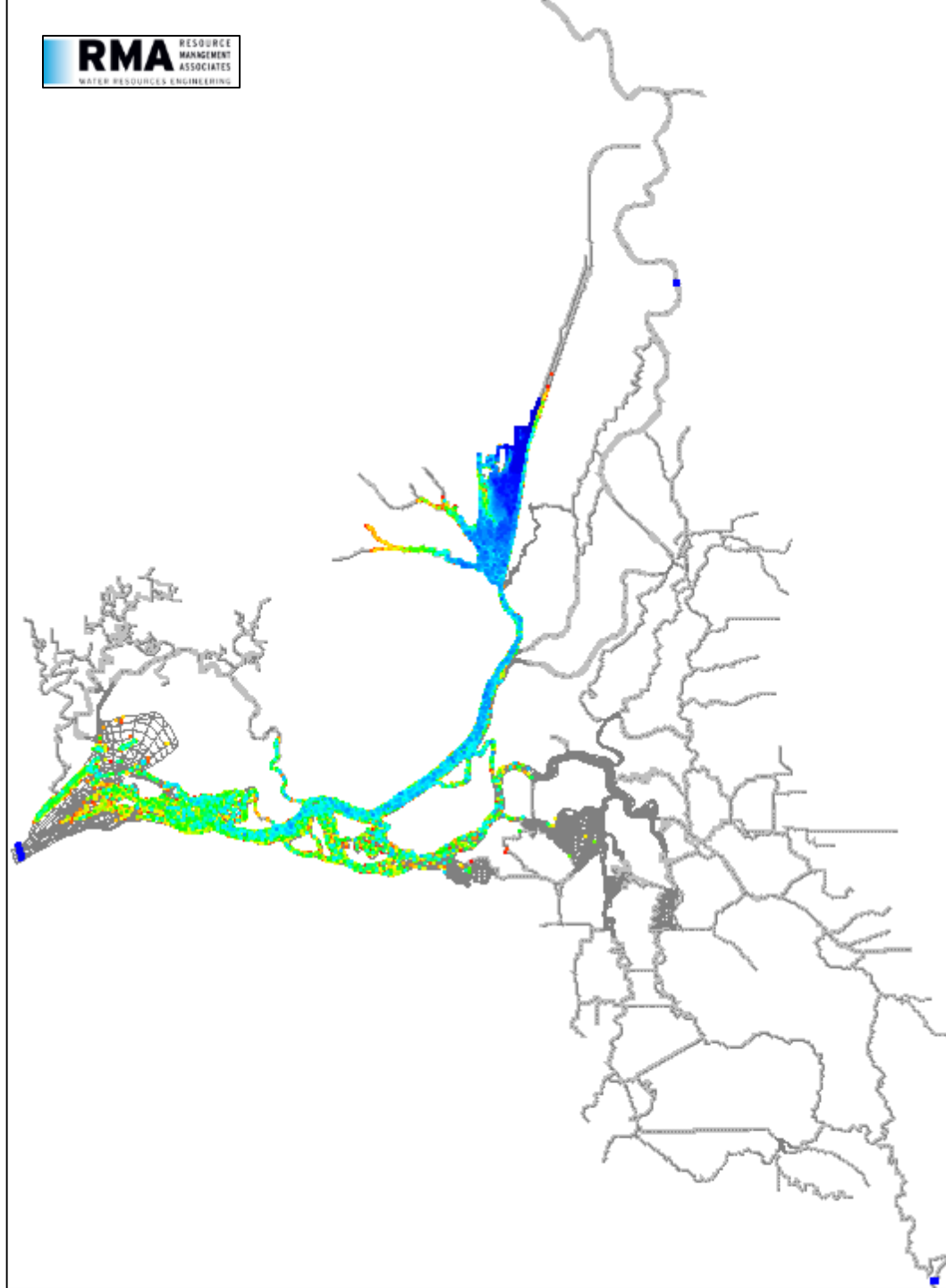
	Count	Regional %	% of Total
Particles Entering	41314	100%	31%
Particles Staying	28963	70%	22%
Particles Leaving	12351	30%	9%

Color Scale Indicates Approximate Age



June 28, 2011 23:45
Yolo Source
Particle Age in Full Delta
134,300 Particles Inserted

Color Scale Indicates Approximate Age

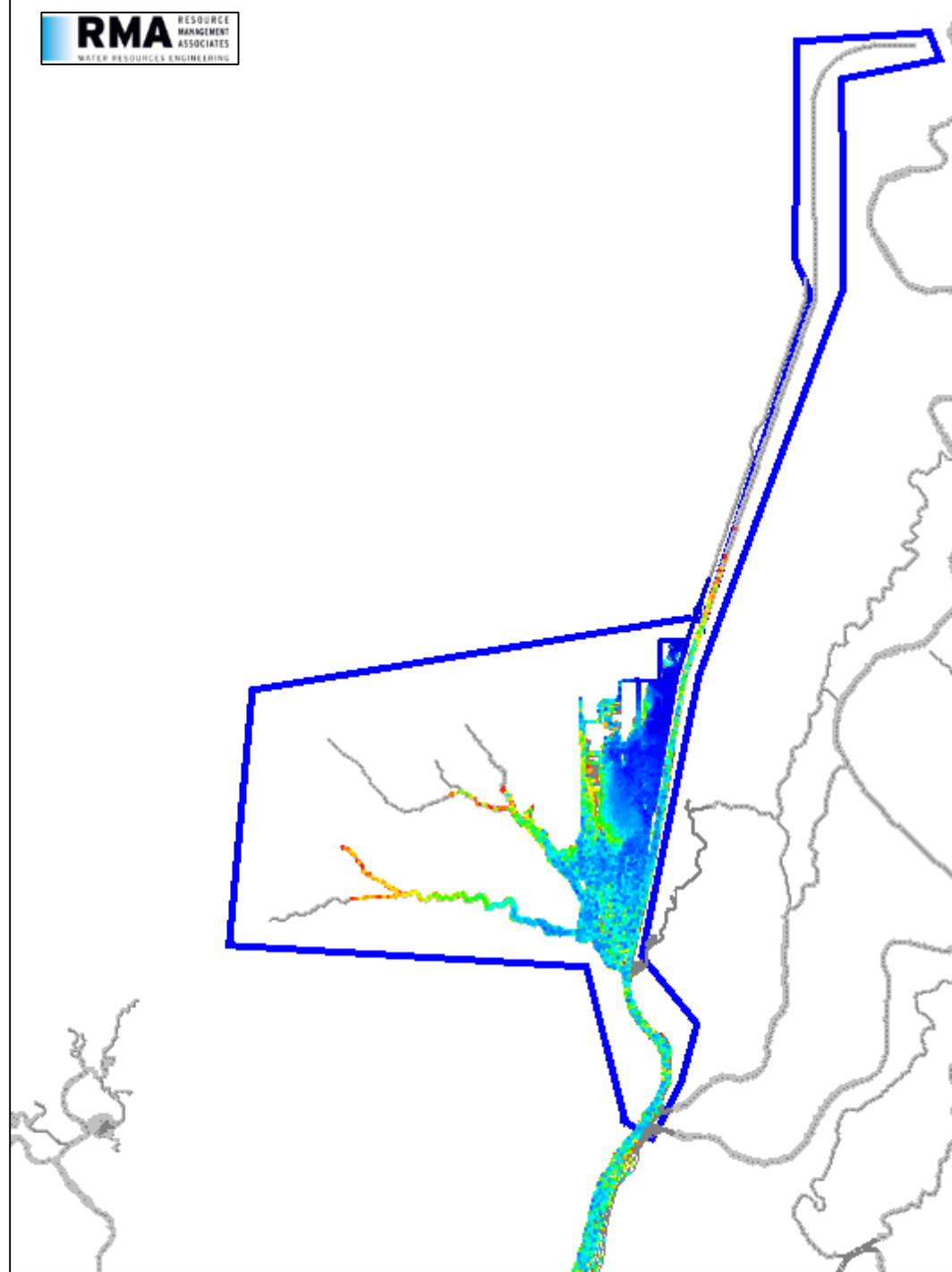
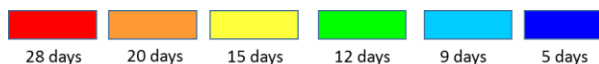


June 28, 2011 23:45
Yolo Source
Particle Age in N. Delta
134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	74%	100%
5 to 10	14%	0%
10 to 15	8%	0%
15 to 20	4%	0%
20 to 25	1%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	133294	100%	99%
Particles Staying	40163	30%	30%
Particles Leaving	93131	70%	69%

Color Scale Indicates Approximate Age



June 28, 2011 23:45

Yolo Source

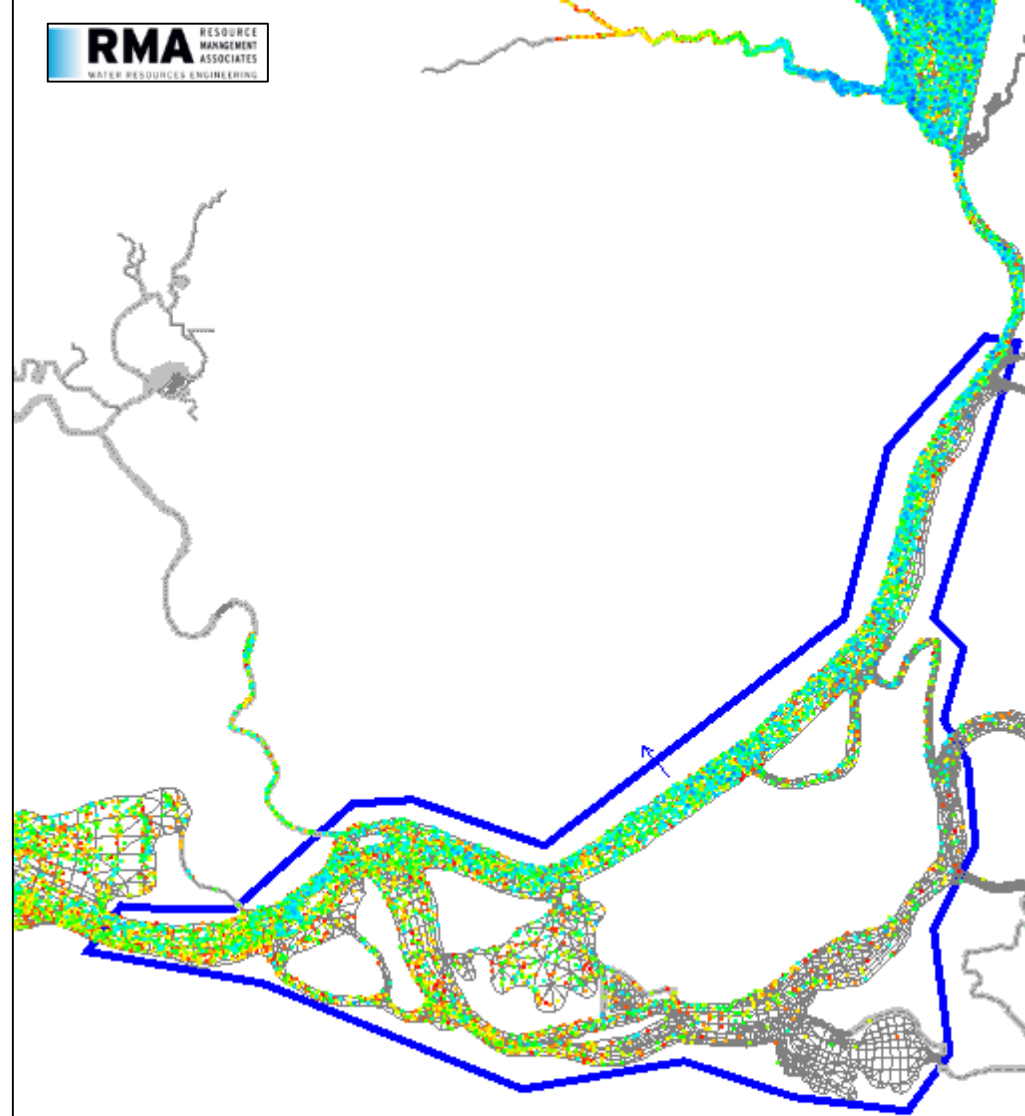
Particle Age in Confluence

134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	11%
5 to 10	24%	45%
10 to 15	39%	27%
15 to 20	25%	13%
20 to 25	10%	4%
25 to 28	2%	0%

	Count	Regional %	% of Total
Particles Entering	40640	100%	30%
Particles Staying	31989	79%	24%
Particles Leaving	8651	21%	6%

Color Scale Indicates Approximate Age

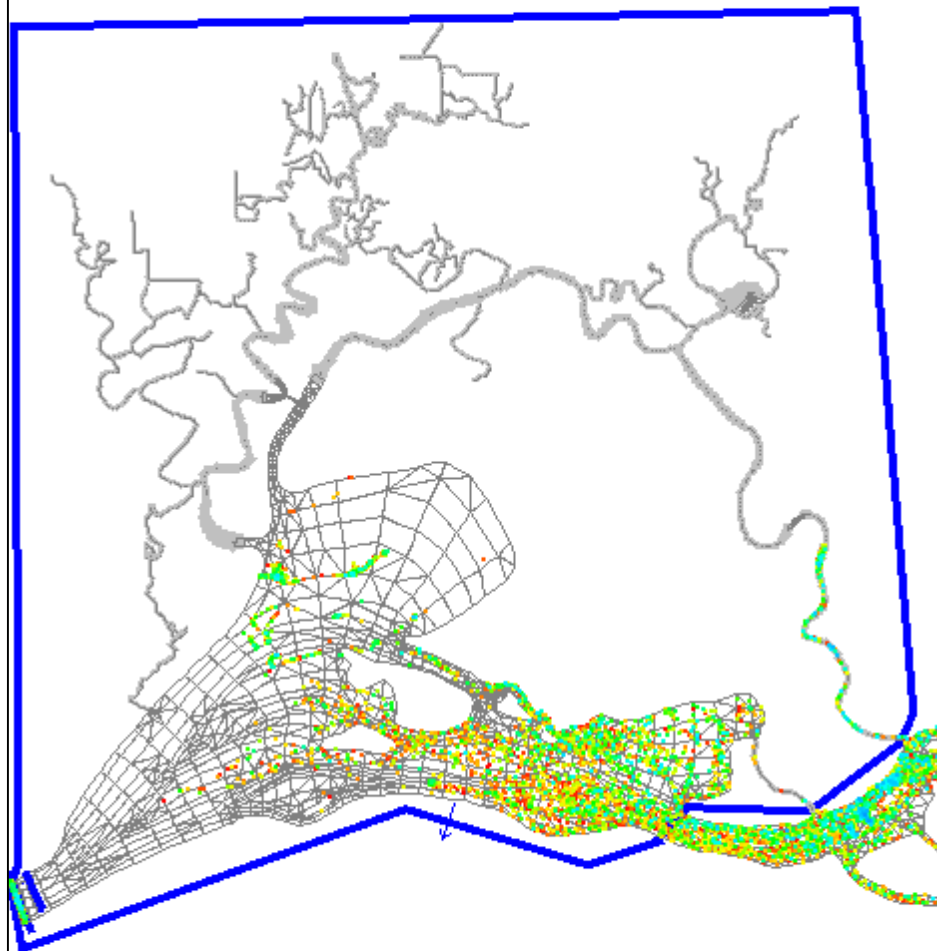


June 28, 2011 23:45
Yolo Source
Particle Age in Suisun Region
134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	57%	67%
10 to 15	93%	93%
15 to 20	57%	52%
20 to 25	21%	18%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	32544	100%	24%
Particles Exiting Upstream	2680	8%	2%
Particles Exiting MTZ	15874	49%	12%

Color Scale Indicates Approximate Age



June 28, 2011 23:45

Yolo Source

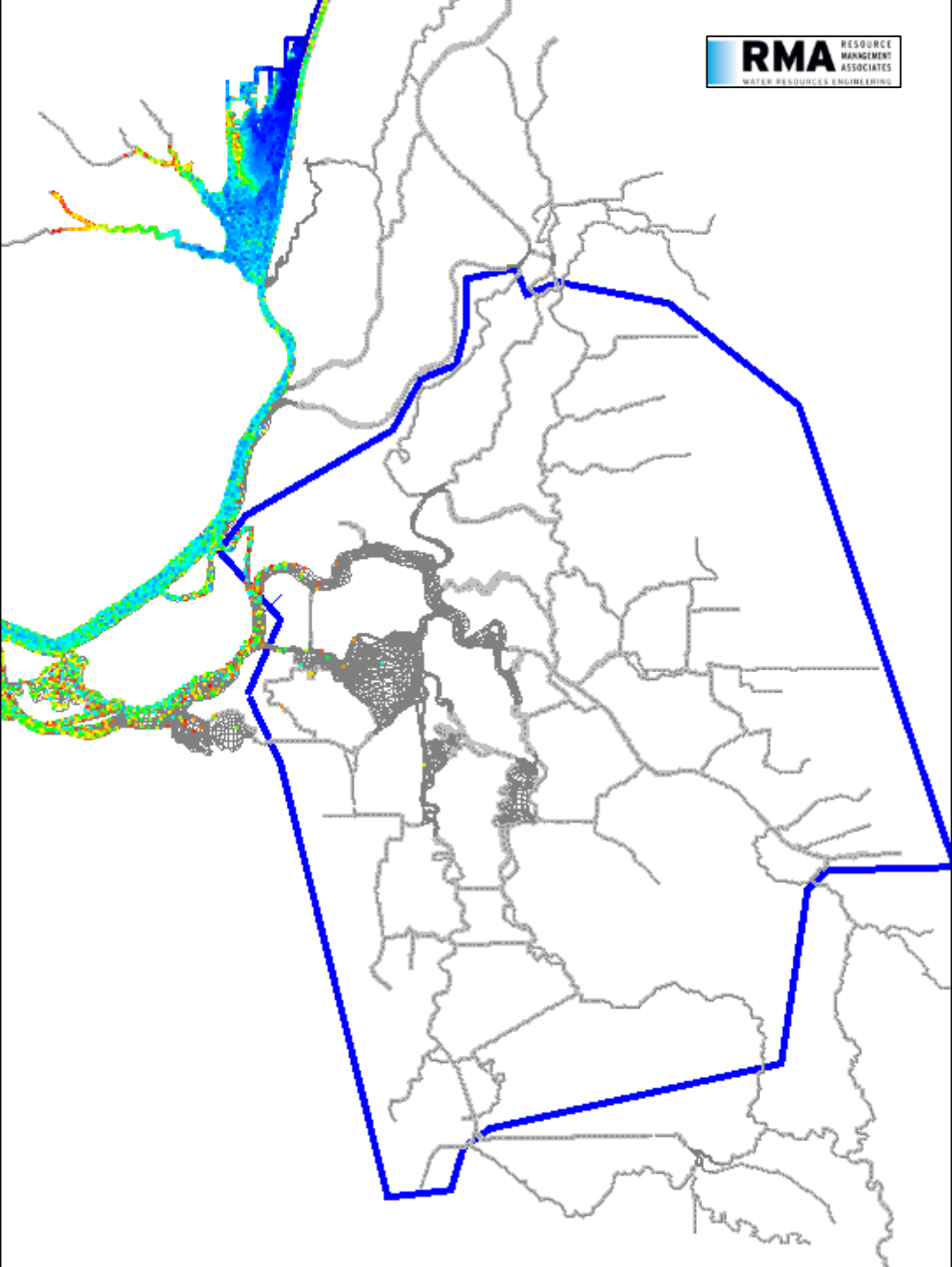
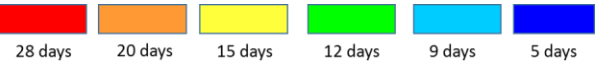
Particle Age in Central Region

134,300 Particles Inserted

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	6%	7%
5 to 10	45%	47%
10 to 15	30%	28%
15 to 20	13%	12%
20 to 25	5%	4%
25 to 28	1%	1%

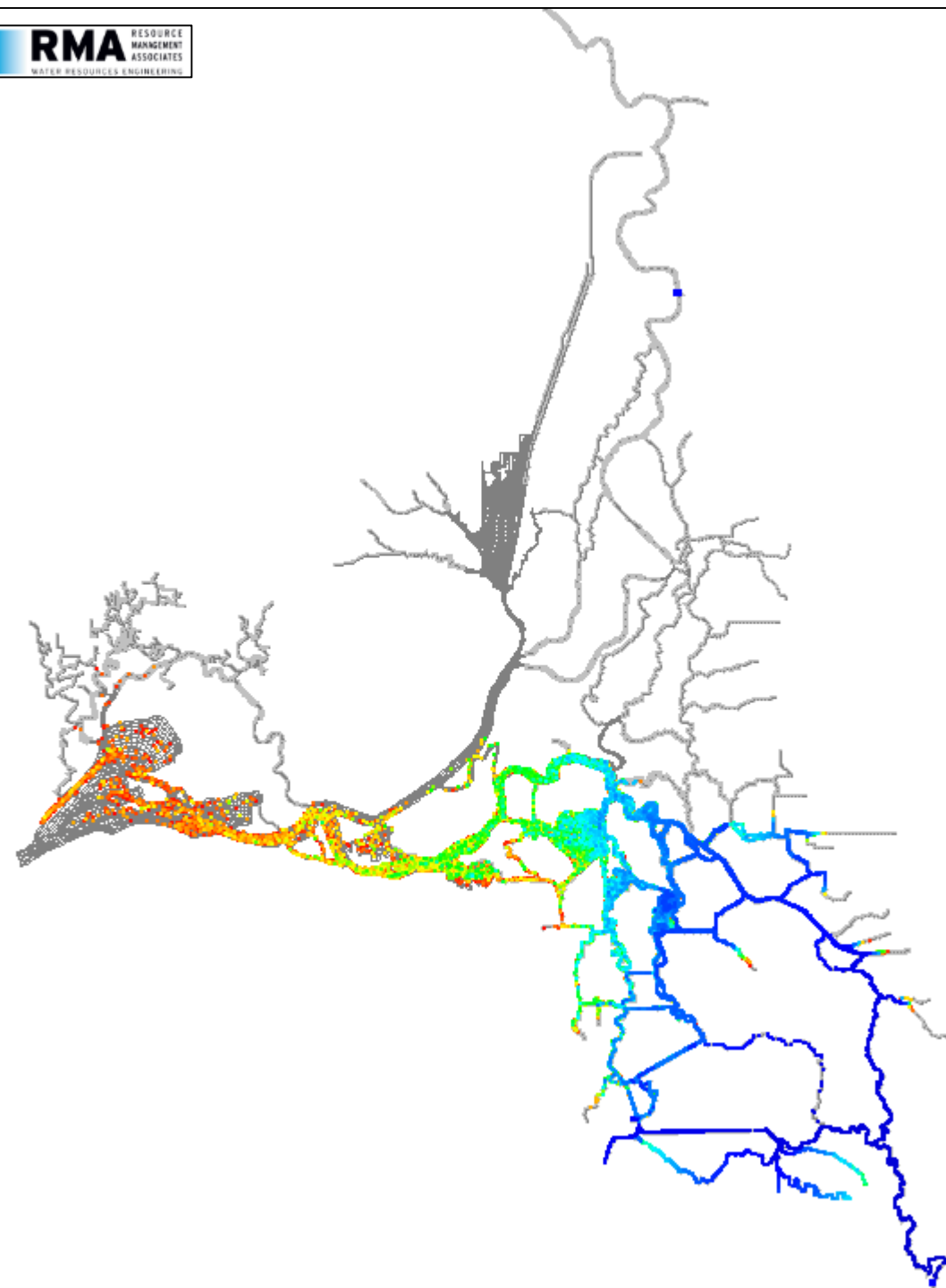
	Count	Regional %	% of Total
Particles Entering	3562	100%	3%
Particles Staying	3445	97%	3%
Particles Leaving	117	3%	0%

Color Scale Indicates Approximate Age



June 28, 2011 23:45
San Joaquin Source
134,300 Particles Inserted
Age in Full Delta

Color Scale Indicates Approximate Age



June 28, 2011 23:45
 San Joaquin Source
 134,300 Particles Inserted
 Age in S. Delta

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	98%	96%
5 to 10	2%	1%
10 to 15	0%	0%
15 to 20	0%	0%
20 to 25	0%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	134300	100%	100%
Particles Staying	126401	94%	94%
Particles Leaving	7899	6%	6%

Color Scale Indicates Approximate Age

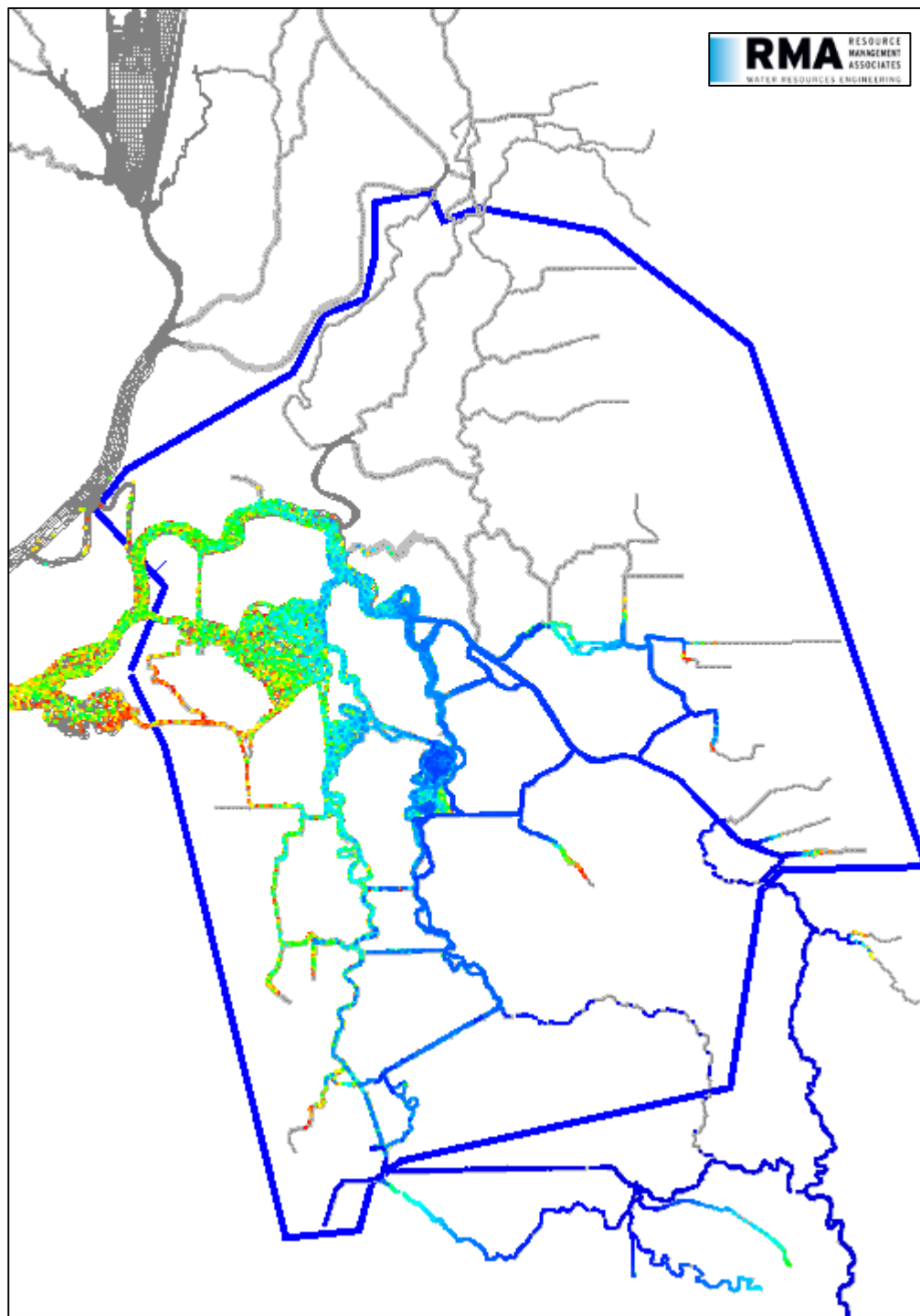


June 28, 2011 23:45
 San Joaquin Source
 134,300 Particles Inserted
 Age in Central Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	93%	99%
5 to 10	2%	1%
10 to 15	2%	0%
15 to 20	2%	0%
20 to 25	1%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	117198	100%	87%
Particles Staying	3813	3%	3%
Particles Leaving	113385	97%	84%

Color Scale Indicates Approximate Age

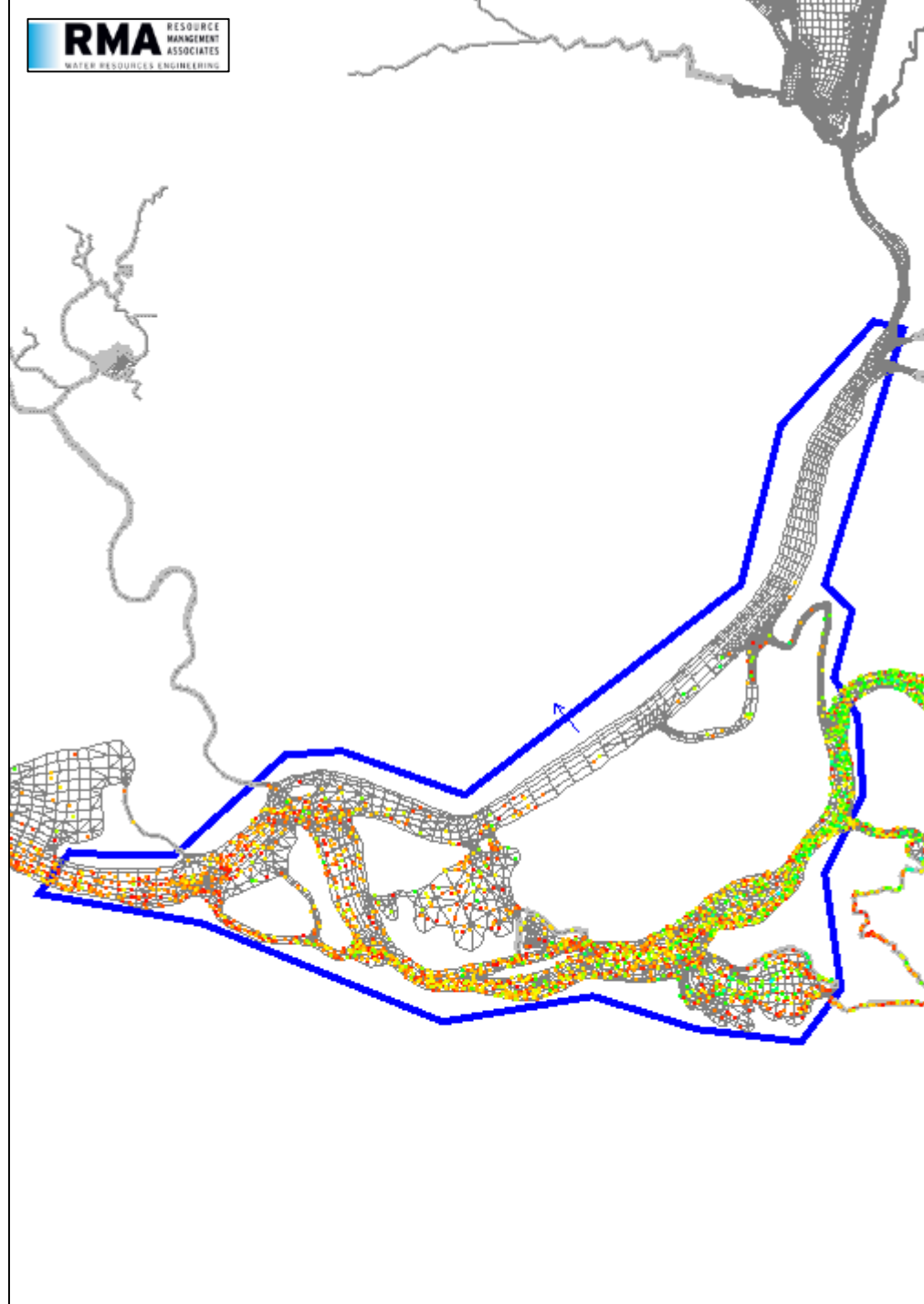


June 28, 2011 23:45
San Joaquin Source
134,300 Particles Inserted
Age in Confluence Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	1%	2%
10 to 15	18%	48%
15 to 20	40%	37%
20 to 25	33%	11%
25 to 28	8%	2%

	Count	Regional %	% of Total
Particles Entering	5283	100%	4%
Particles Staying	2644	50%	2%
Particles Leaving	2639	50%	2%

Color Scale Indicates Approximate Age

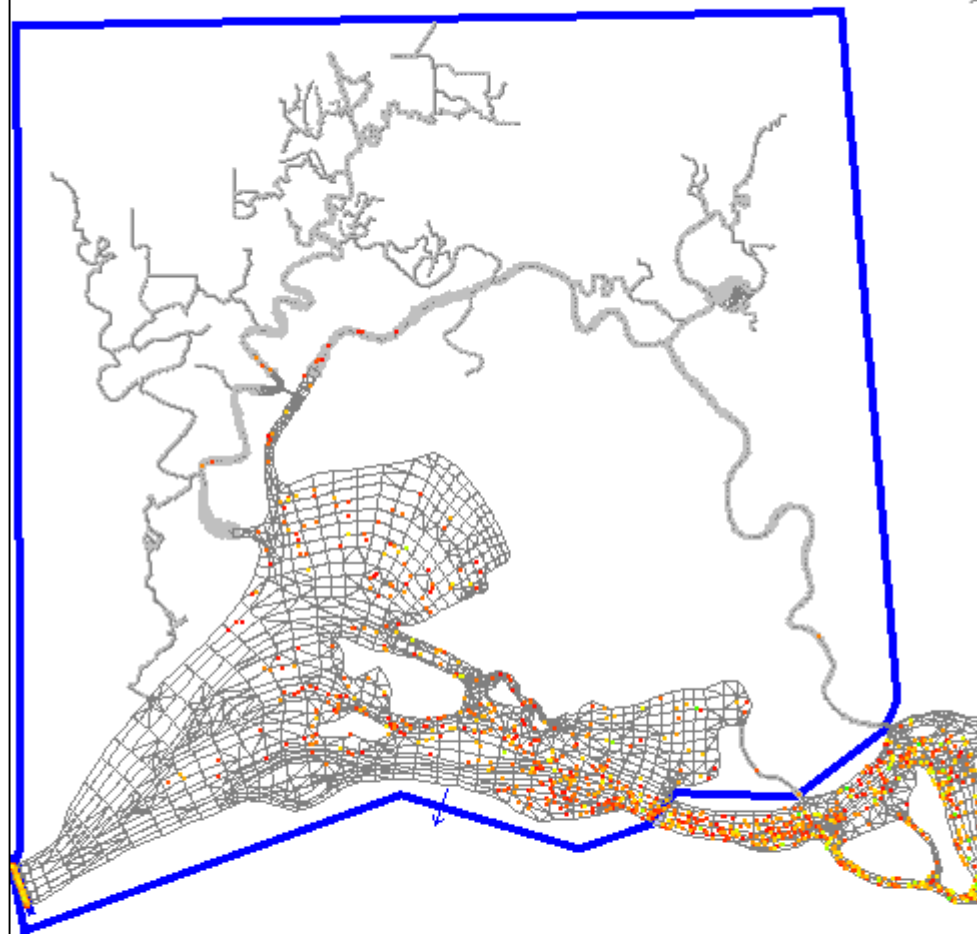


June 28, 2011 23:45
San Joaquin Source
134,300 Particles Inserted
Age in Suisun Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	0%	0%
10 to 15	2%	4%
15 to 20	34%	44%
20 to 25	49%	45%
25 to 28	15%	8%

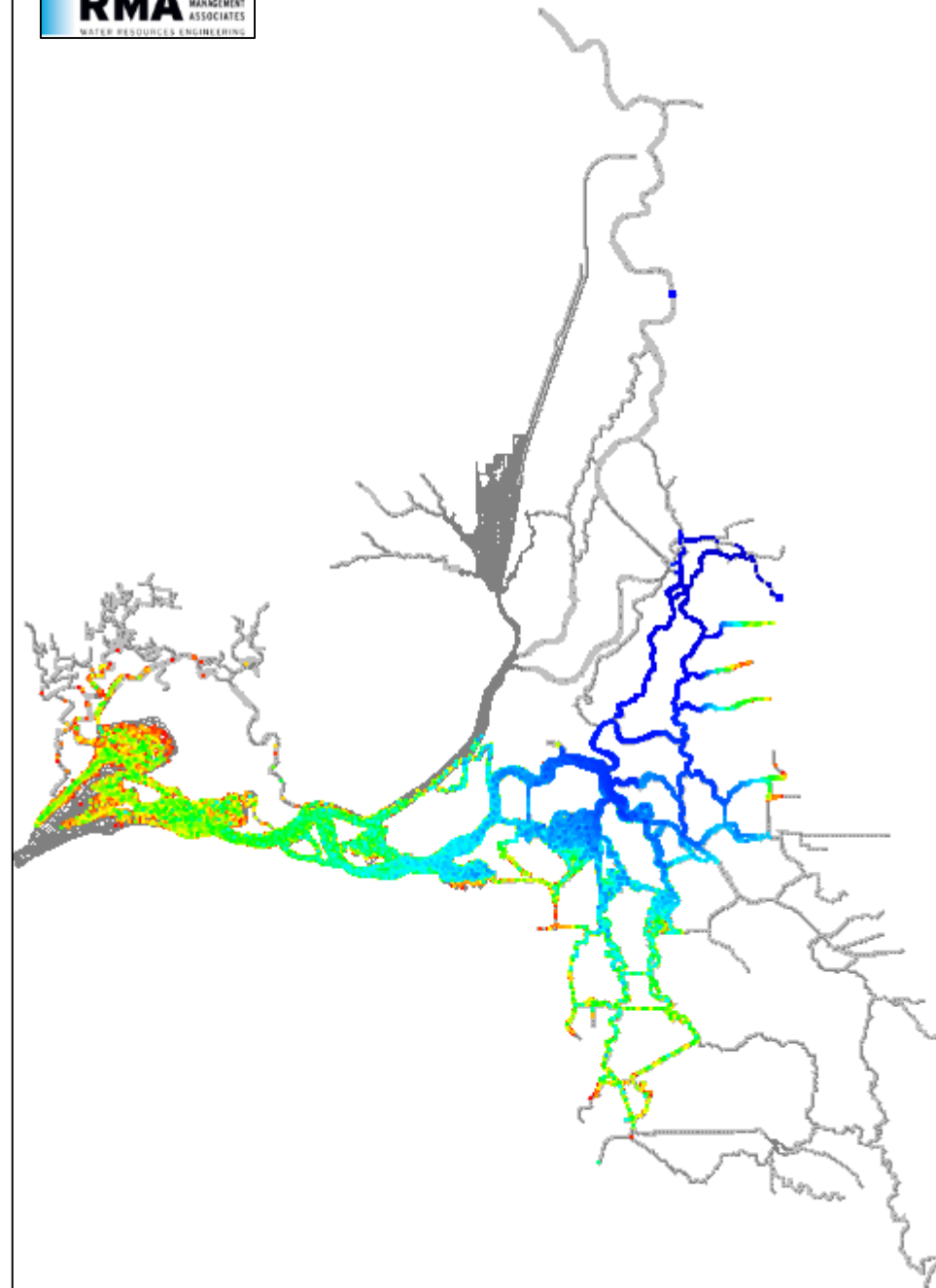
	Count	Regional %	% of Total
Particles Entering	1816	100%	1%
Particles Exiting Upstream	515	28%	0%
Particles Exiting MTZ	848	47%	1%

Color Scale Indicates Approximate Age



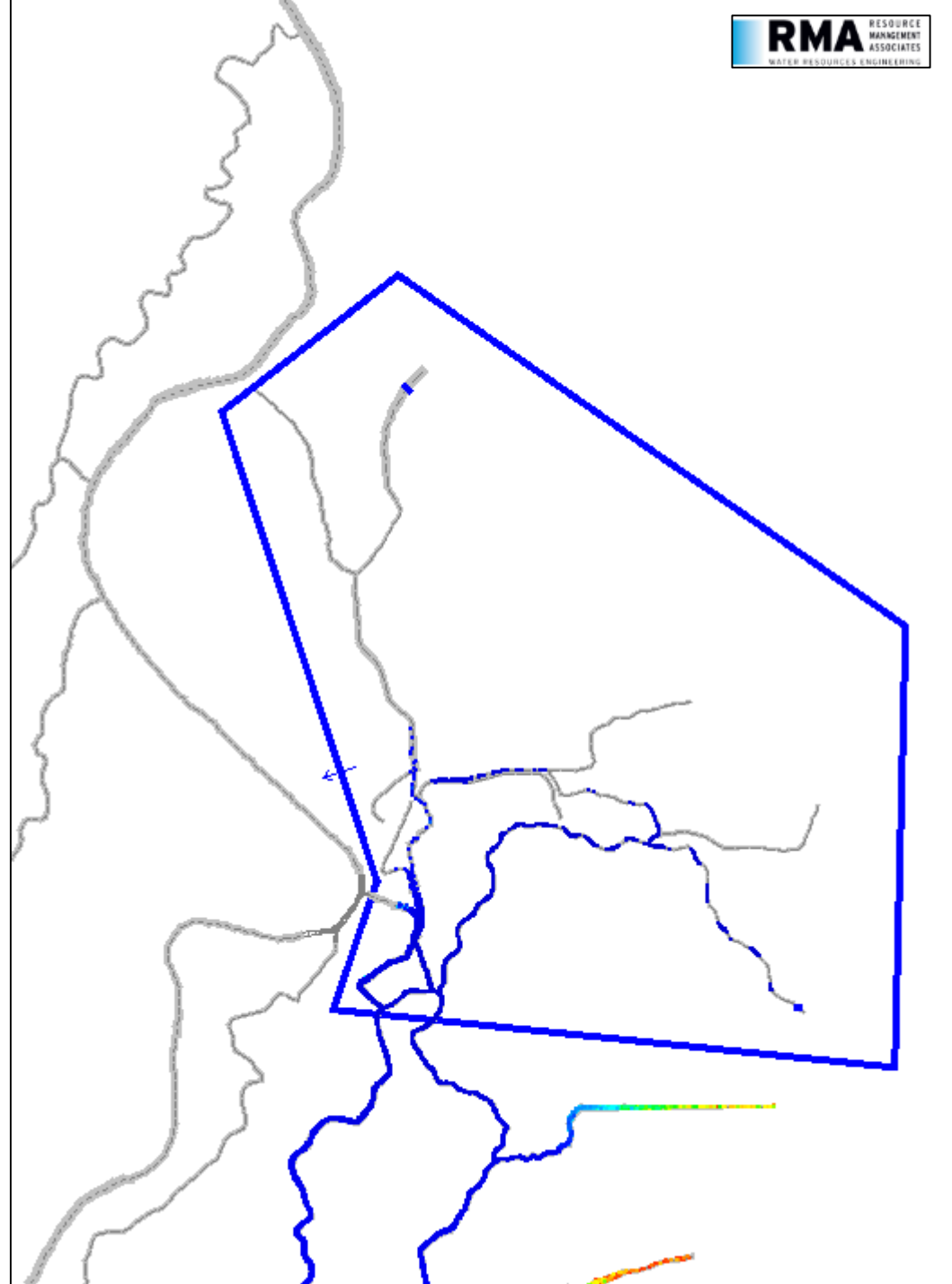
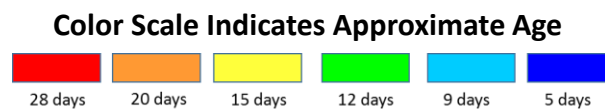
June 28, 2011 23:45
Mokelumne Source
134,300 Particles Inserted
Age in Full Delta

Color Scale Indicates Approximate Age



June 28, 2011 23:45
Mokelumne Source
134,300 Particles Inserted
Age in Eastside Region

Statistics not calculated

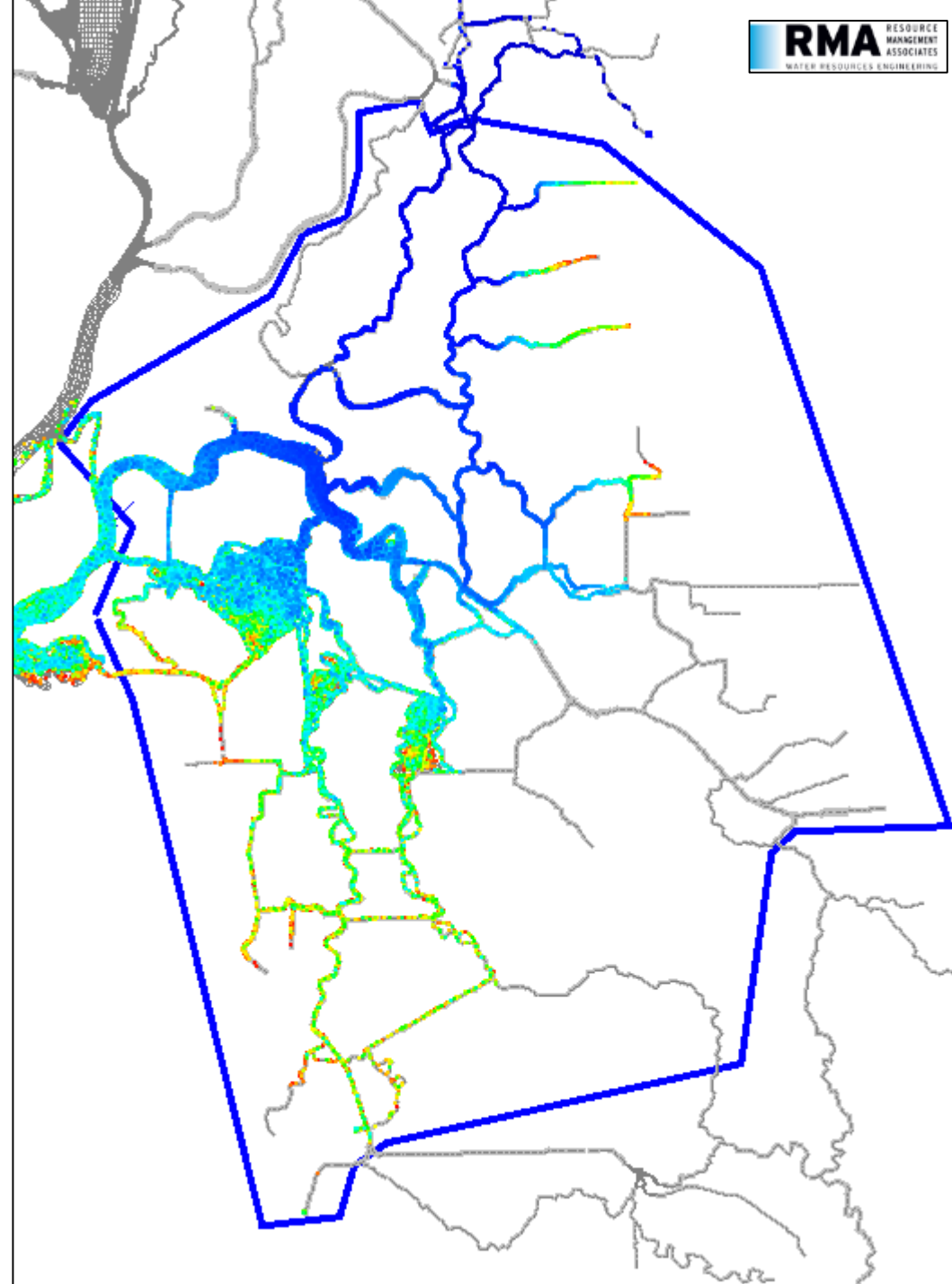


June 28, 2011 23:45
Mokelumne Source
134,300 Particles Inserted
Age in Central Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	62%	99%
5 to 10	10%	1%
10 to 15	14%	0%
15 to 20	10%	0%
20 to 25	3%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	132918	100%	99%
Particles Staying	38725	29%	29%
Particles Leaving	94193	71%	70%

Color Scale Indicates Approximate Age

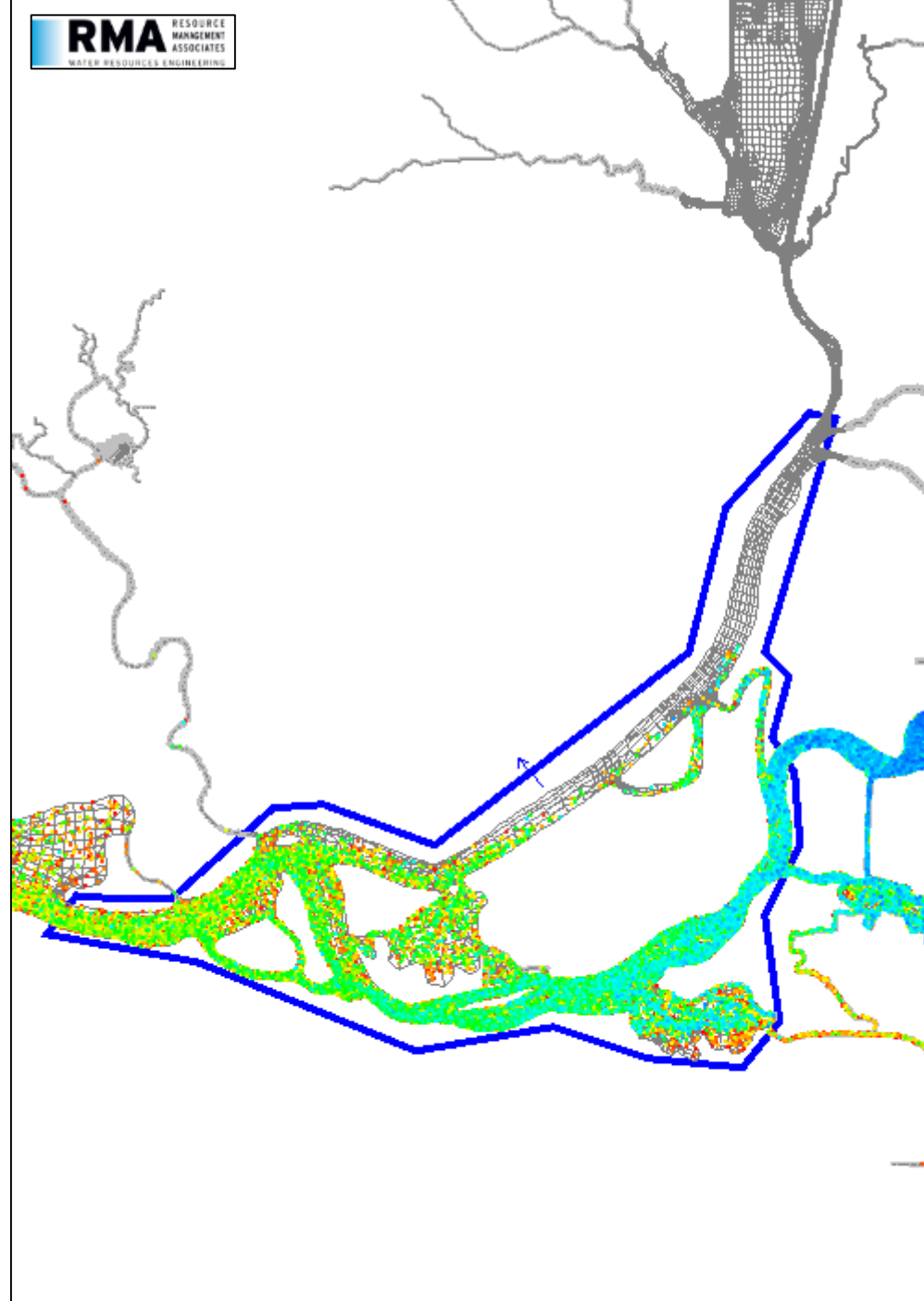


June 28, 2011 23:45
Mokelumne Source
134,300 Particles Inserted
Age in Confluence Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	13%	41%
10 to 15	27%	33%
15 to 20	37%	21%
20 to 25	19%	5%
25 to 28	4%	0%

	Count	Regional %	% of Total
Particles Entering	50712	100%	38%
Particles Staying	28104	55%	21%
Particles Leaving	22608	45%	17%

Color Scale Indicates Approximate Age

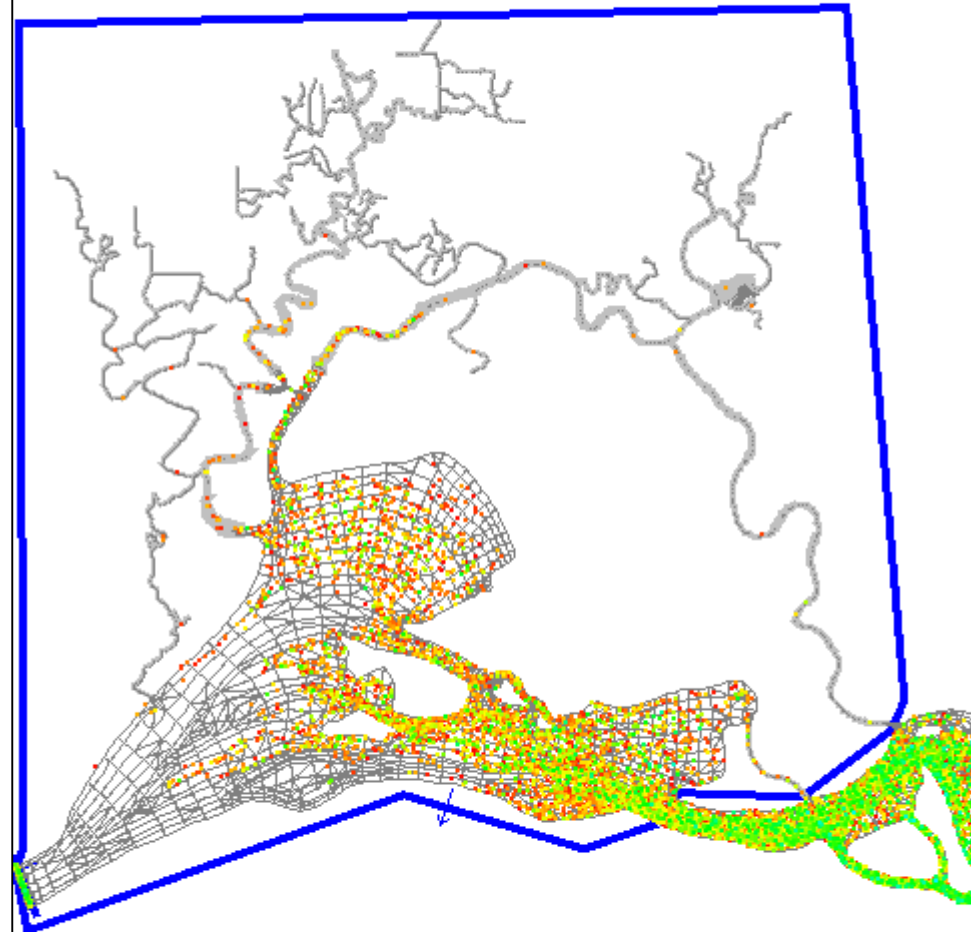


June 28, 2011 23:45
Mokelumne Source
134,300 Particles Inserted
Age in Suisun Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	0%	0%
10 to 15	20%	28%
15 to 20	46%	45%
20 to 25	28%	23%
25 to 28	6%	3%

	Count	Regional %	% of Total
Particles Entering	21113	100%	16%
Particles Exiting Upstream	5161	24%	4%
Particles Exiting MTZ	12006	57%	9%

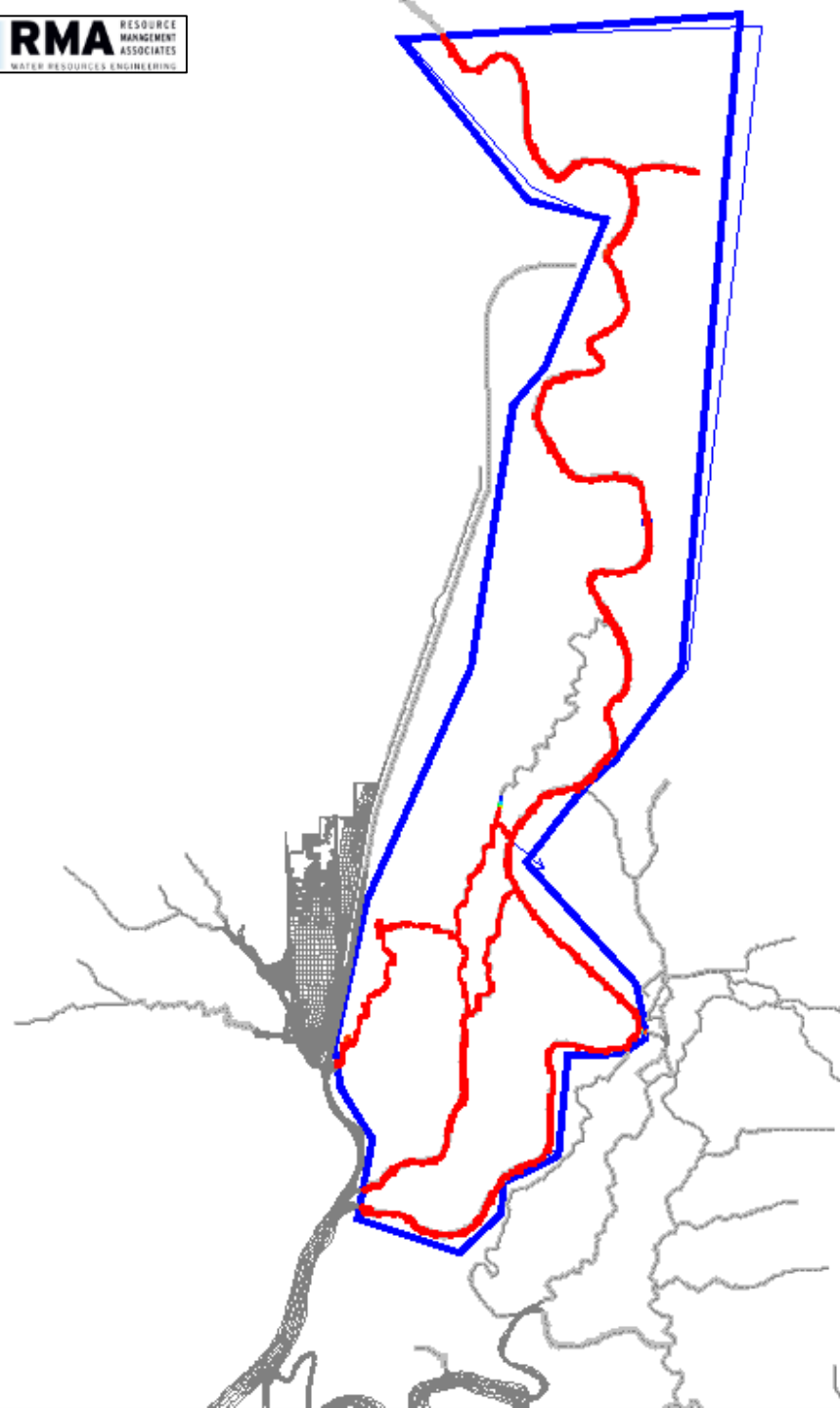
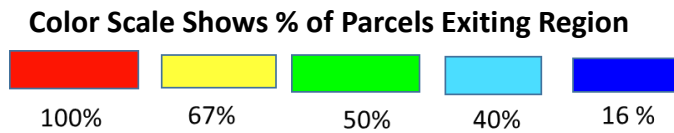
Color Scale Indicates Approximate Age



June 28, 2011 23:45
Sac Region Fate Map
99,814 Particles Inserted

Statistics not calculated

(cell size = 100, 100,000 particles)



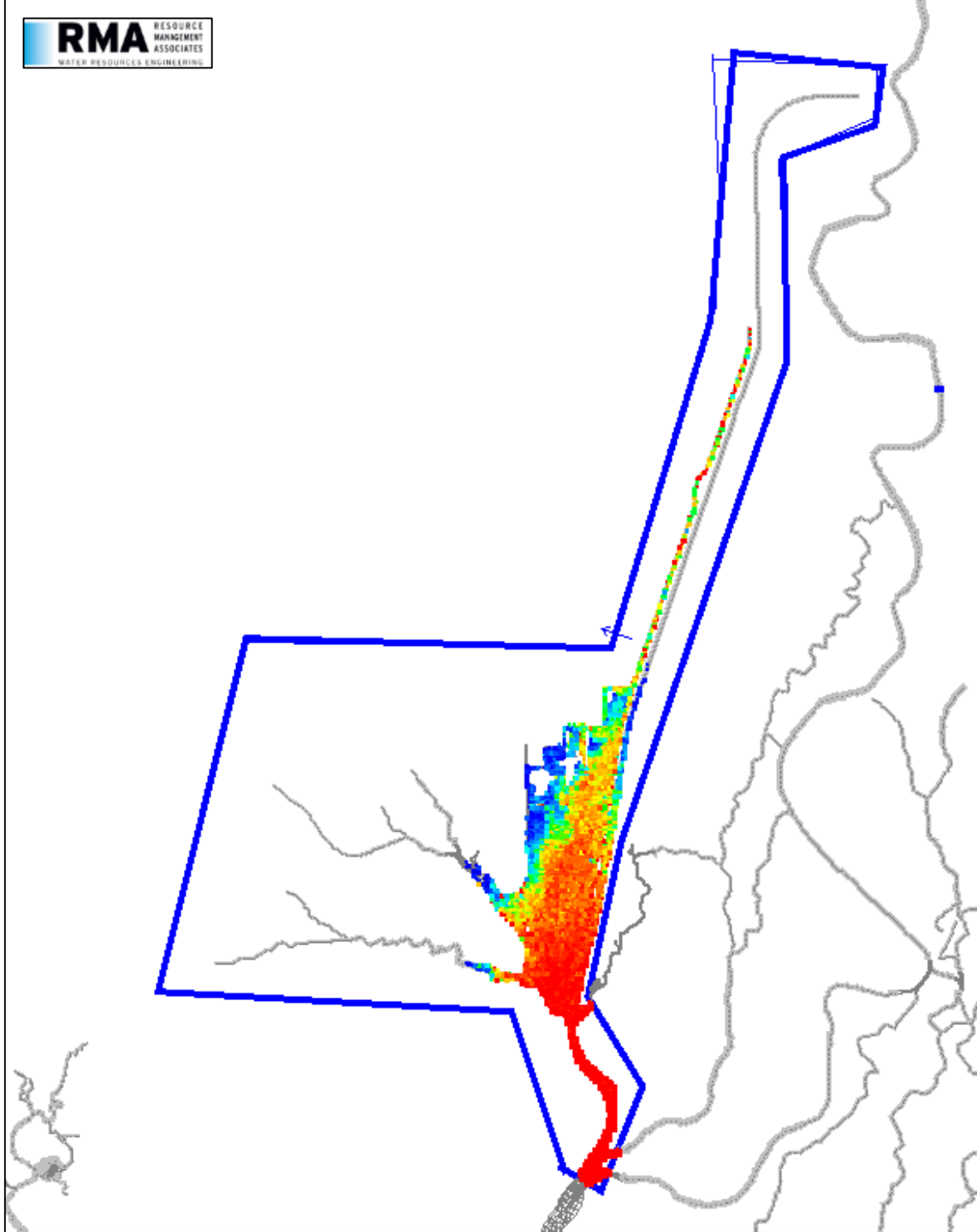
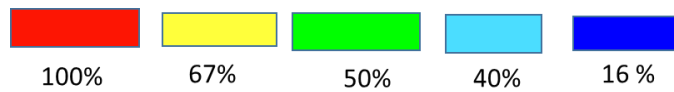
June 28, 2011 23:45
North Delta Region Fate Map
148,429 Particles Inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	30%
5 to 10	16%
10 to 15	11%
15 to 20	5%
20 to 25	3%
25-28	1%
>28	34%

	Count	% of Total
Particles Staying	50377	34%
Particles Leaving	98064	66%

Color Scale Shows % of Parcels Exiting Region



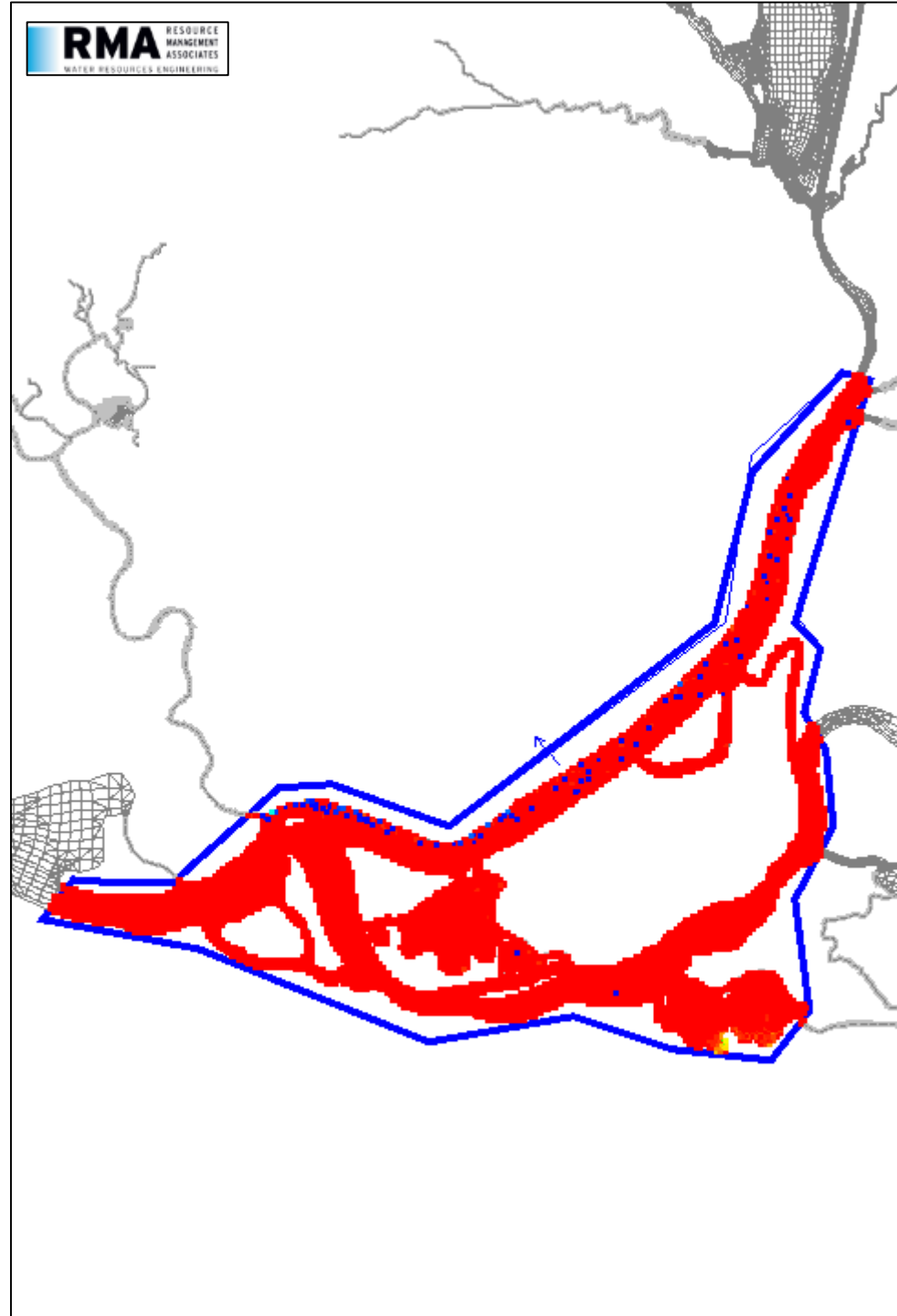
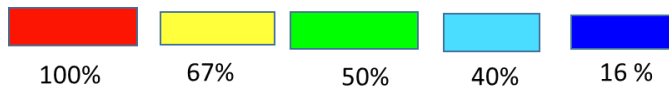
June 28, 2011 23:45
Confluence Region Fate Map
149,225 Particles Inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	88%
5 to 10	10%
10 to 15	1%
15 to 20	0%
20 to 25	0%
25-28	0%
>28	1%

	Count	% of Total
Particles Staying	819	1%
Particles Leaving	148406	99%

Color Scale Shows % of Parcels Exiting Region



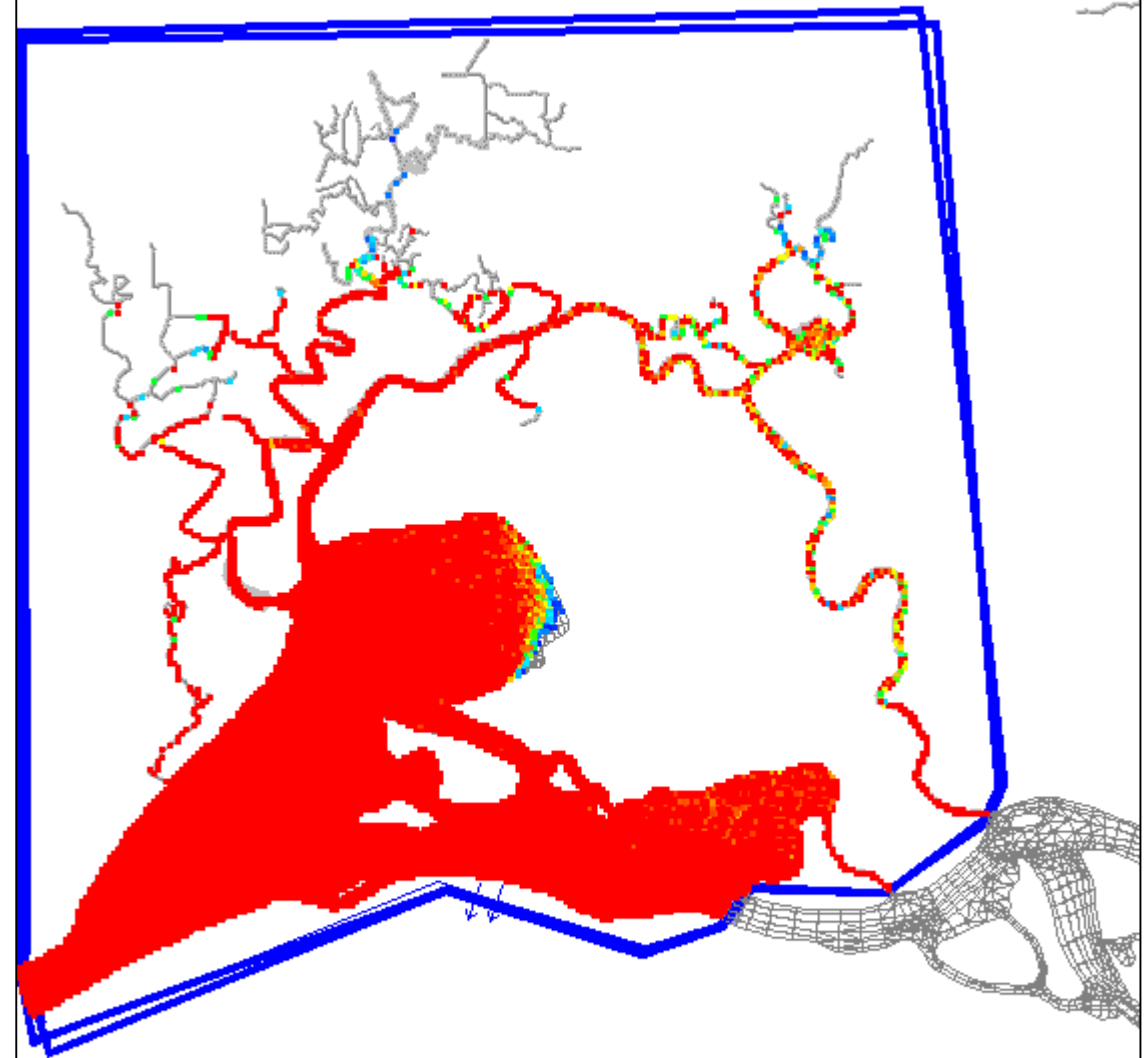
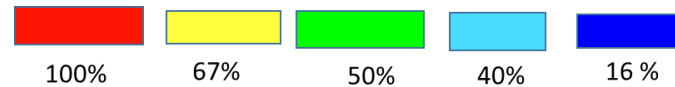
June 28, 2011 23:45
Suisun Region Fate Map
99,421 Particles Inserted

(cell size = 100, 100,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	83%
5 to 10	6%
10 to 15	3%
15 to 20	2%
20 to 25	1%
25-28	1%
>28	4%

	Count	% of Total
Particles Staying	3977	4%
Particles Leaving	95444	96%

Color Scale Shows % of Parcels Exiting Region



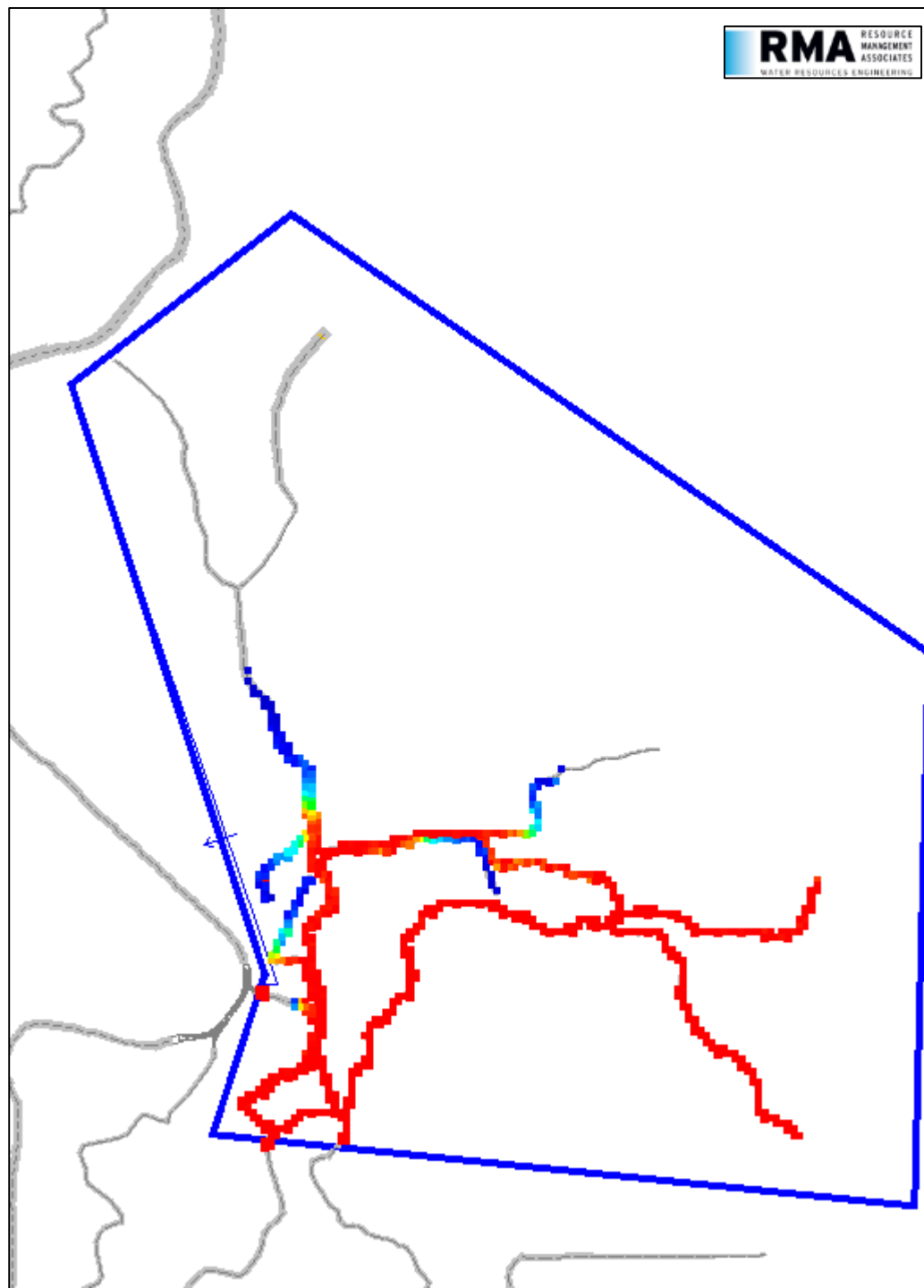
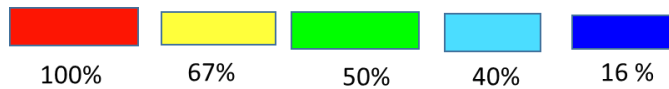
June 28, 2011 23:45
Eastside Region Fate Map
99,867 Particles Inserted

(cell size = 100, 100,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	50%
5 to 10	2%
10 to 15	1%
15 to 20	0%
20 to 25	1%
25-28	0%
>28	46%

	Count	% of Total
Particles Staying	45852	46%
Particles Leaving	54015	54%

Color Scale Shows % of Parcels Exiting Region

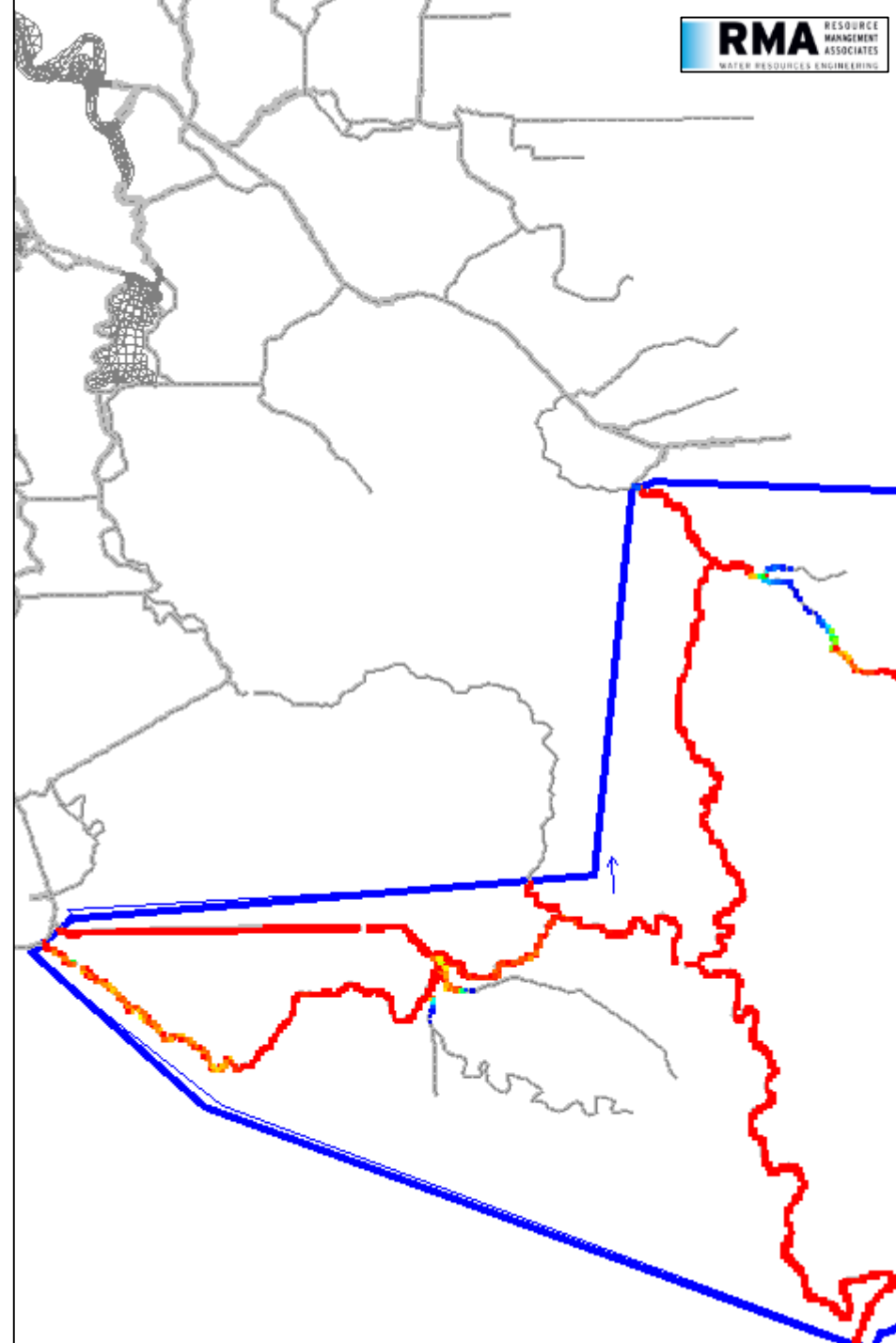
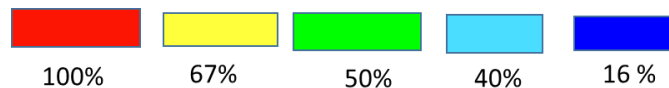


June 28, 2011 23:45
South Delta Region Fate Map
99,835 Particles Inserted

Statistics not computed.

(cell size = 100, 100,000 particles)

Color Scale Shows % of Parcels Exiting Region



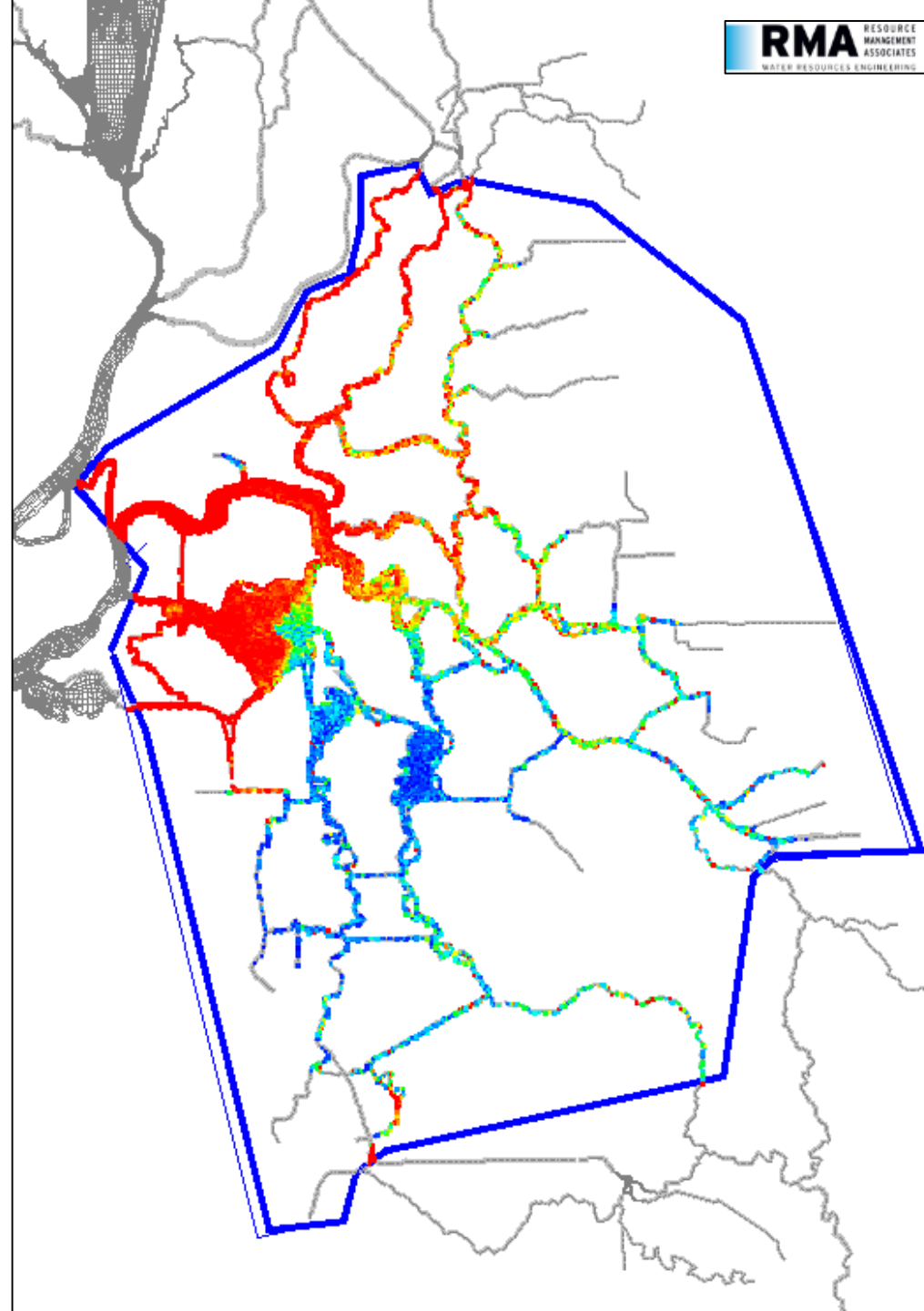
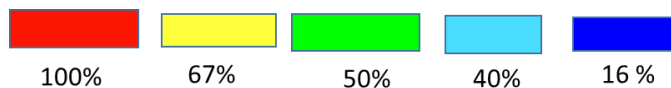
June 28, 2011 23:45
Central Region Fate Map
148,798 Particles Inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	39%
5 to 10	12%
10 to 15	7%
15 to 20	3%
20 to 25	1%
25-28	0%
>28	38%

	Count	% of Total
Particles Staying	56967	38%
Particles Leaving	91831	62%

Color Scale Shows % of Parcels Exiting Region



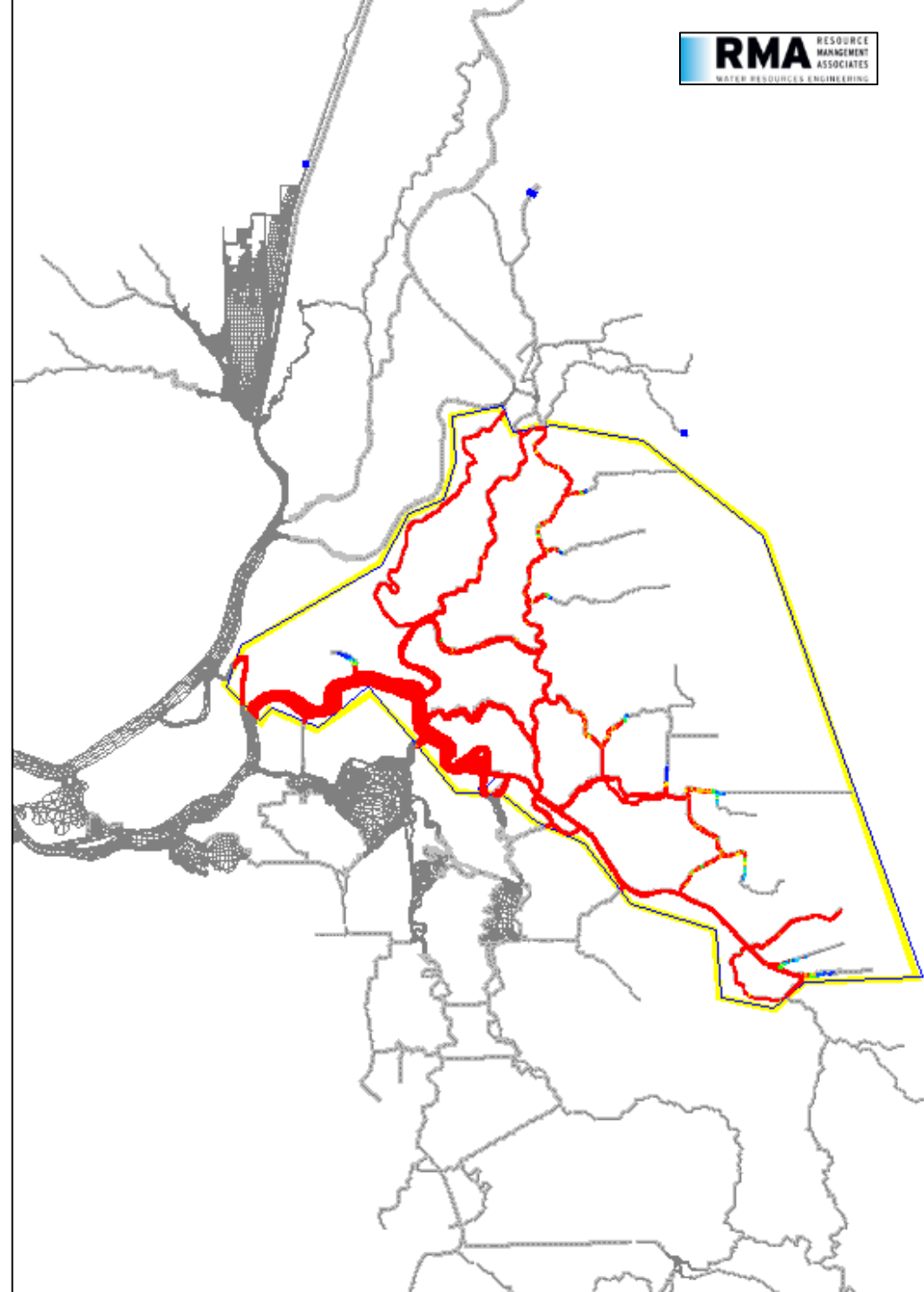
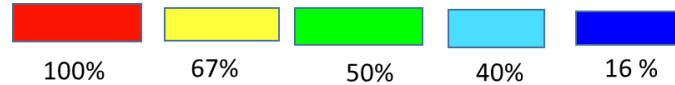
June 28, 2011 23:45
Central-Upper Region Fate Map
149,030 Particles Inserted

(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	67%
5 to 10	16%
10 to 15	6%
15 to 20	1%
20 to 25	0%
25-28	0%
>28	9%

	Count	% of Total
Particles Staying	13471	9%
Particles Leaving	135559	91%

Color Scale Shows % of Parcels Exiting Region



June 28, 2011 23:45
Central-Lower Region Fate Map
149,053 Particles Inserted

(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	44%
5 to 10	9%
10 to 15	4%
15 to 20	2%
20 to 25	1%
25-28	0%
>28	40%

	Count	% of Total
Particles Staying	60288	40%
Particles Leaving	88765	60%

Color Scale Shows % of Parcels Exiting Region

