

Appendix 2: Fate and Age Exposure Time Maps for low-flow conditions, September 2008

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: Sept. 01, 2008 00:15 to Sept. 28, 2008 23:45
 - RMA Logo can be ungrouped and moved
 - NOTE – the velocity file for the Sept. 2008 simulations was sourced from the calibration modeling from the Prospect Island project
- 50 particles inserted near inflow locations every 15 min. during the simulation
 - Particles inserted in Sacramento, Yolo+Lisbon, San Joaquin, Mokelumne sources
 - NOTE: Cosumnes particles did not move from boundary
 - 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 Sept. 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

September 2008 is the Low flow analysis period

	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

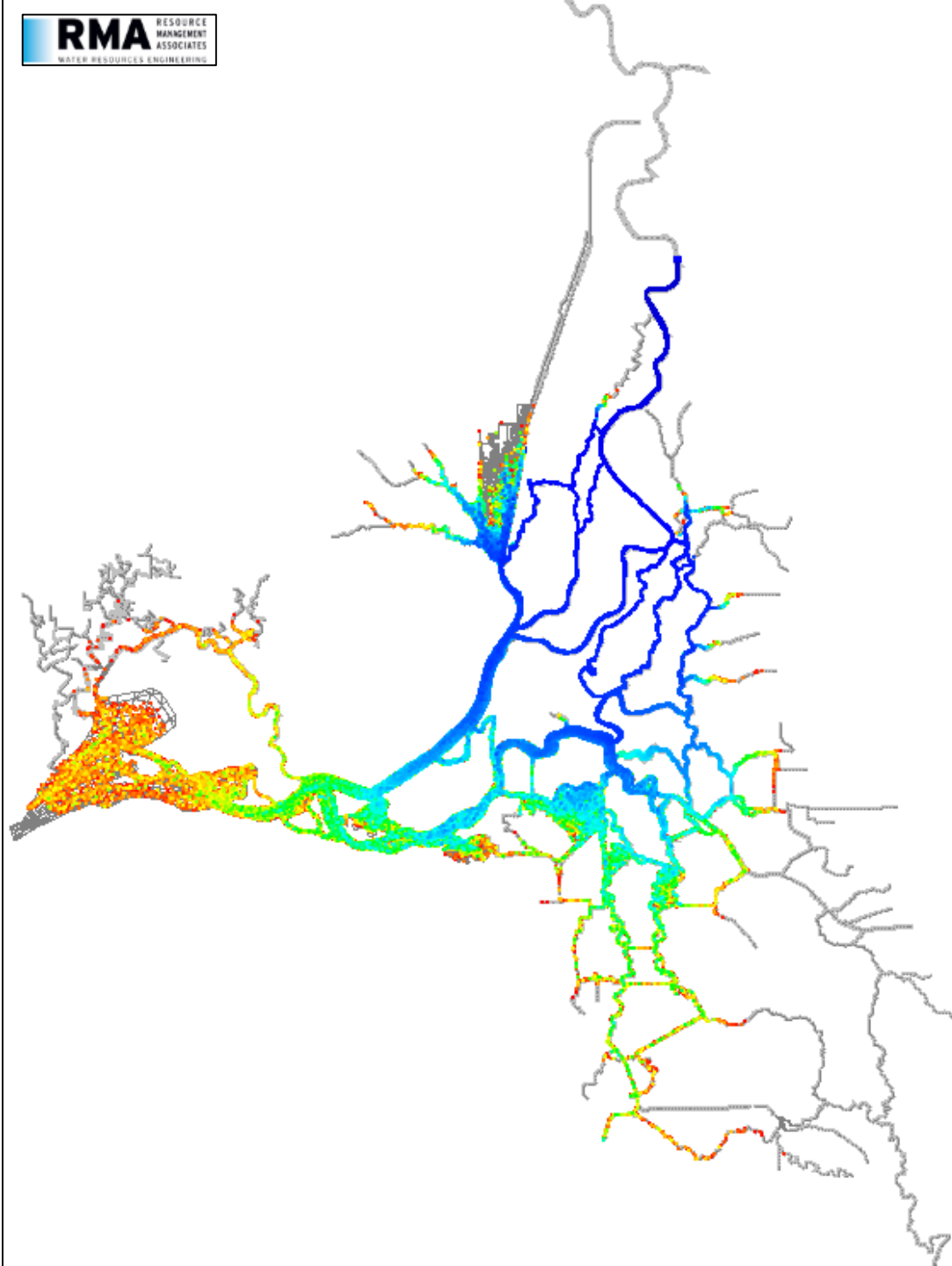
Structures – Gate and Barrier Positions

	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

Sept.28, 2008 23:45
Sacramento Source
134,300 Particles Inserted

Age in Full Delta

Color Scale Indicates Approximate Age



Age on exit from region

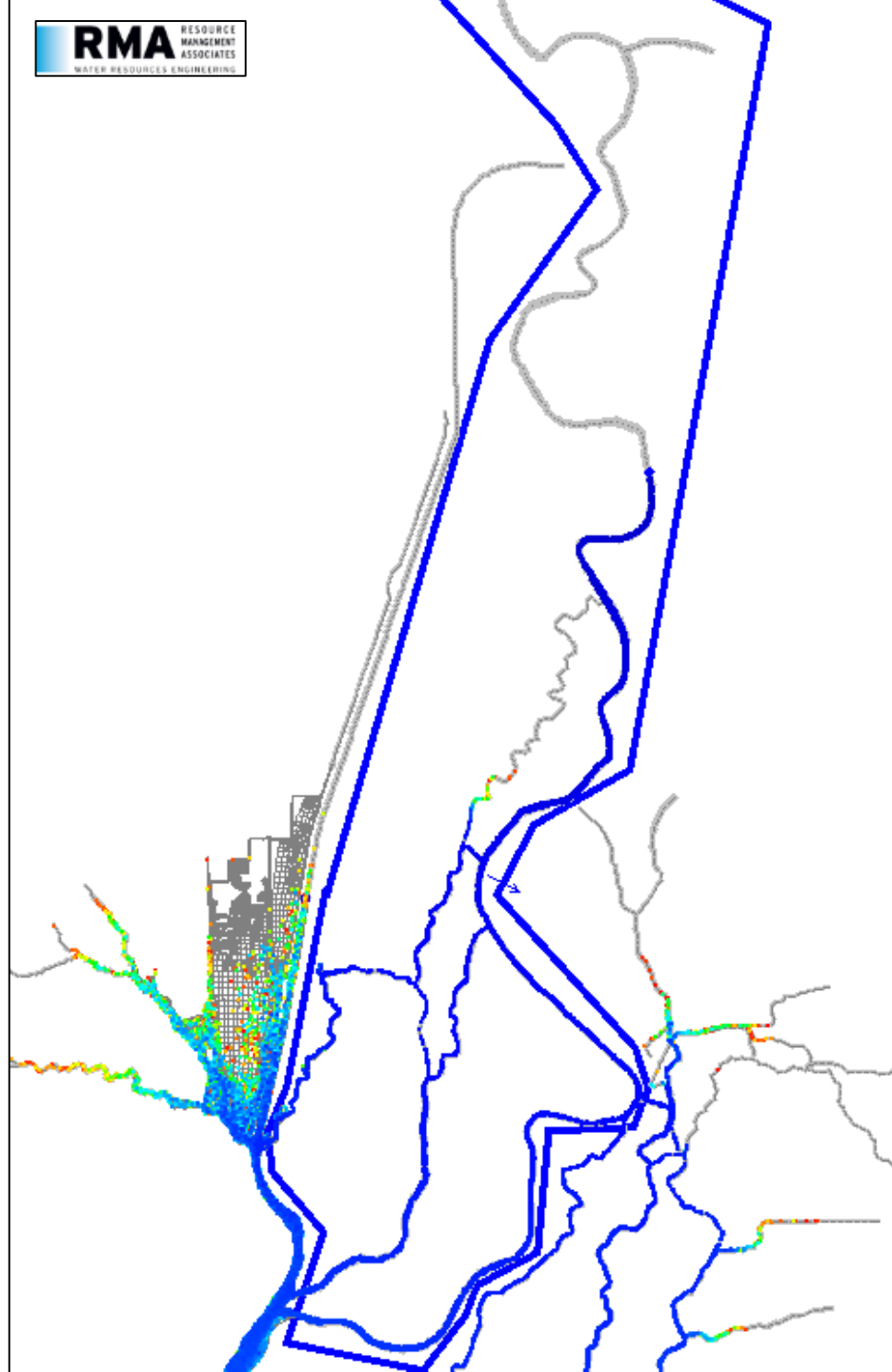
Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	86%	95%
5 to 10	10%	4%
10 to 15	3%	1%
15 to 20	1%	0%
20 to 25	0%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	134300	100%	100%
Particles Staying	27619	21%	21%
Particles Leaving	106681	79%	79%

Sept.28, 2008 23:45
Sacramento Source
134,300 Particles Inserted

Age in Sac Region

Color Scale Indicates Approximate Age



Sept.28, 2008 23:45
Sacramento Source
134,300 Particles Inserted

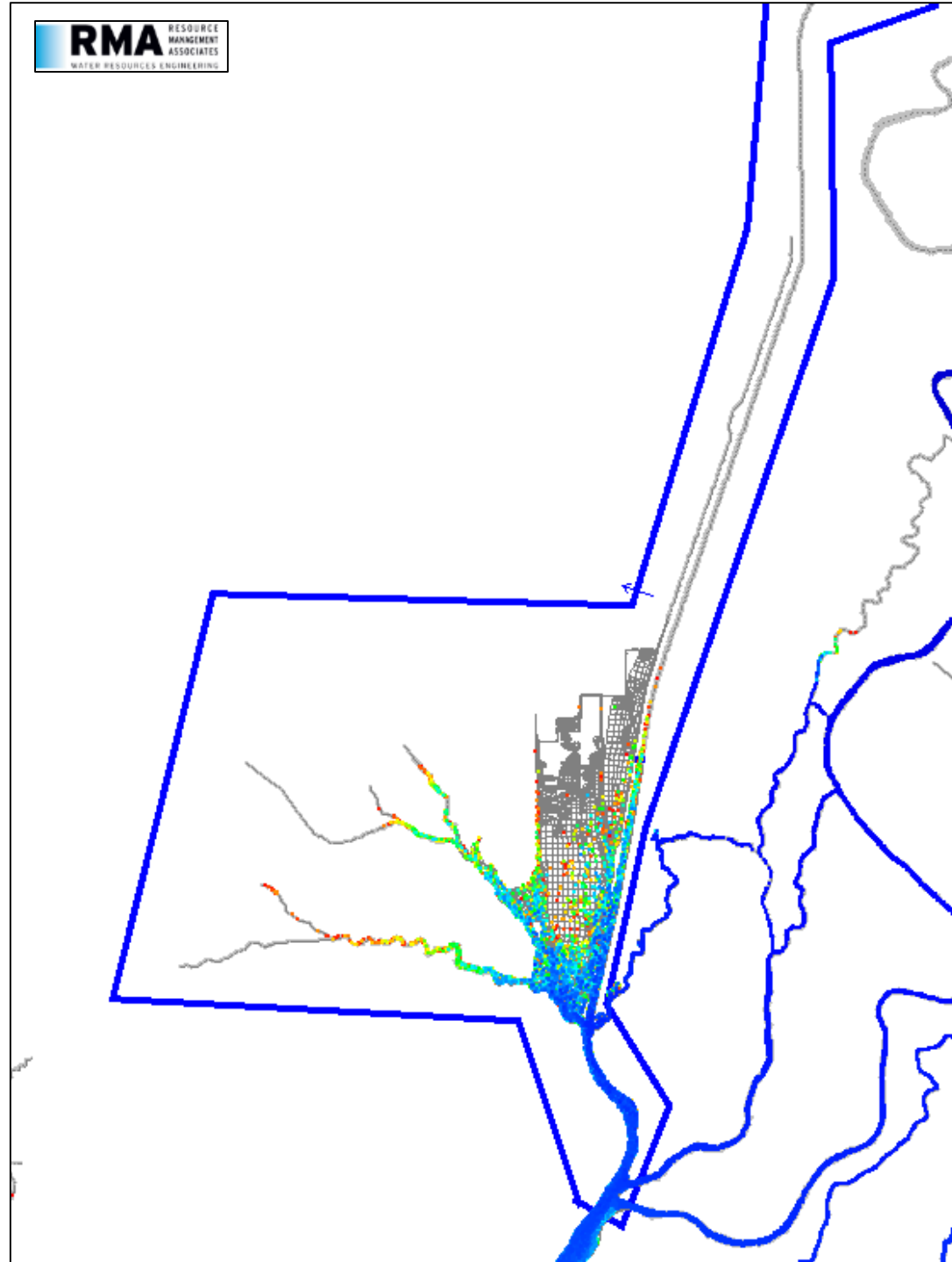
Age in N. Delta region

View on outgoing tide

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	20%	60%
5 to 10	62%	38%
10 to 15	14%	2%
15 to 20	4%	0%
20 to 25	1%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	50554	100%	38%
Particles Staying	8903	18%	7%
Particles Leaving	41651	82%	31%

Color Scale Indicates Approximate Age



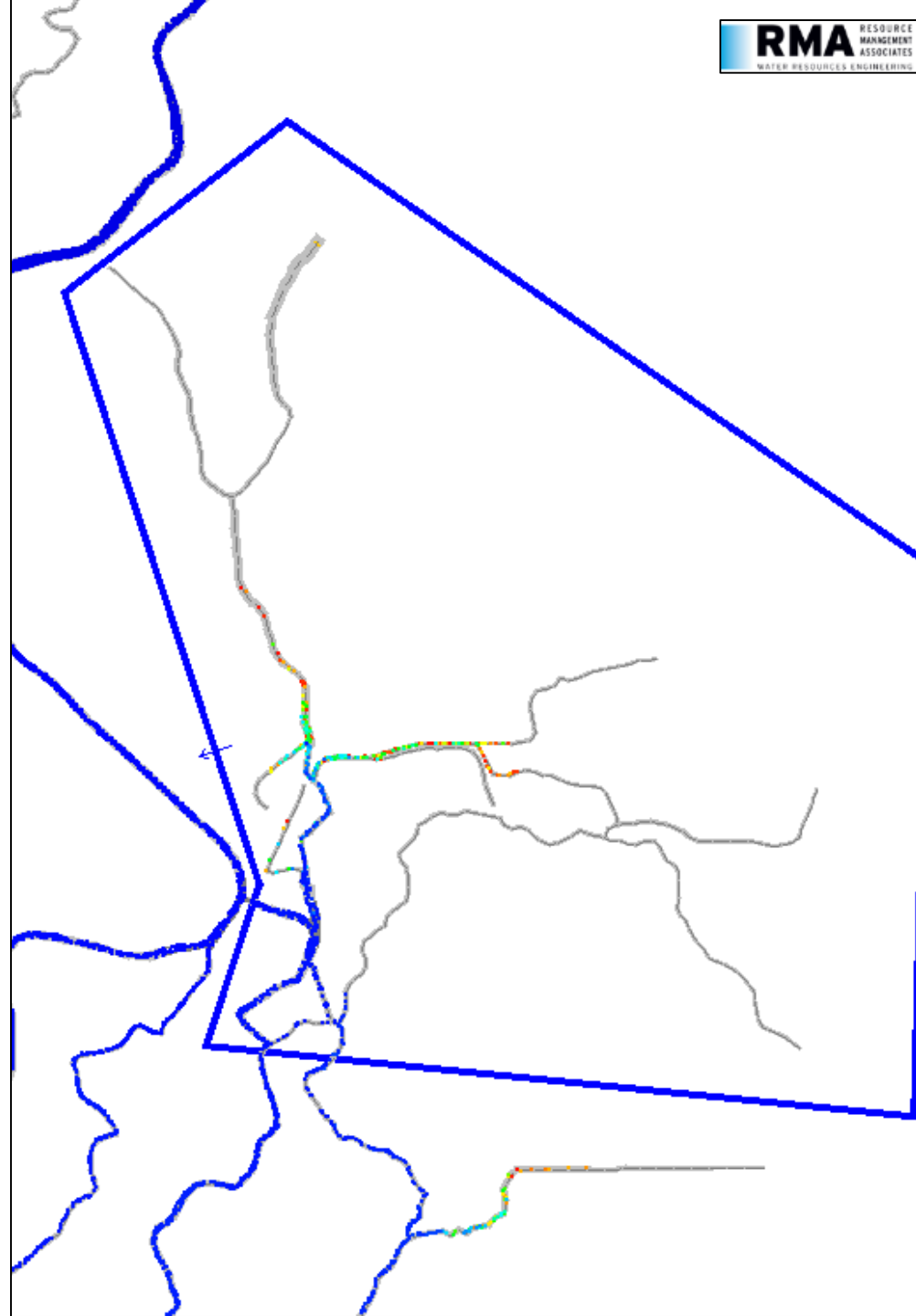
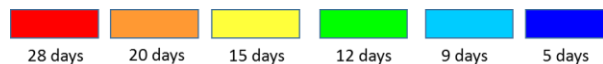
Sept.28, 2008 23:45
Sacramento Source
134,300 Particles Inserted

Age in Eastside Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	100%	100%
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	34994	100%	26%
Particles Staying	34174	98%	25%
Particles Leaving	820	2%	1%

Color Scale Indicates Approximate Age



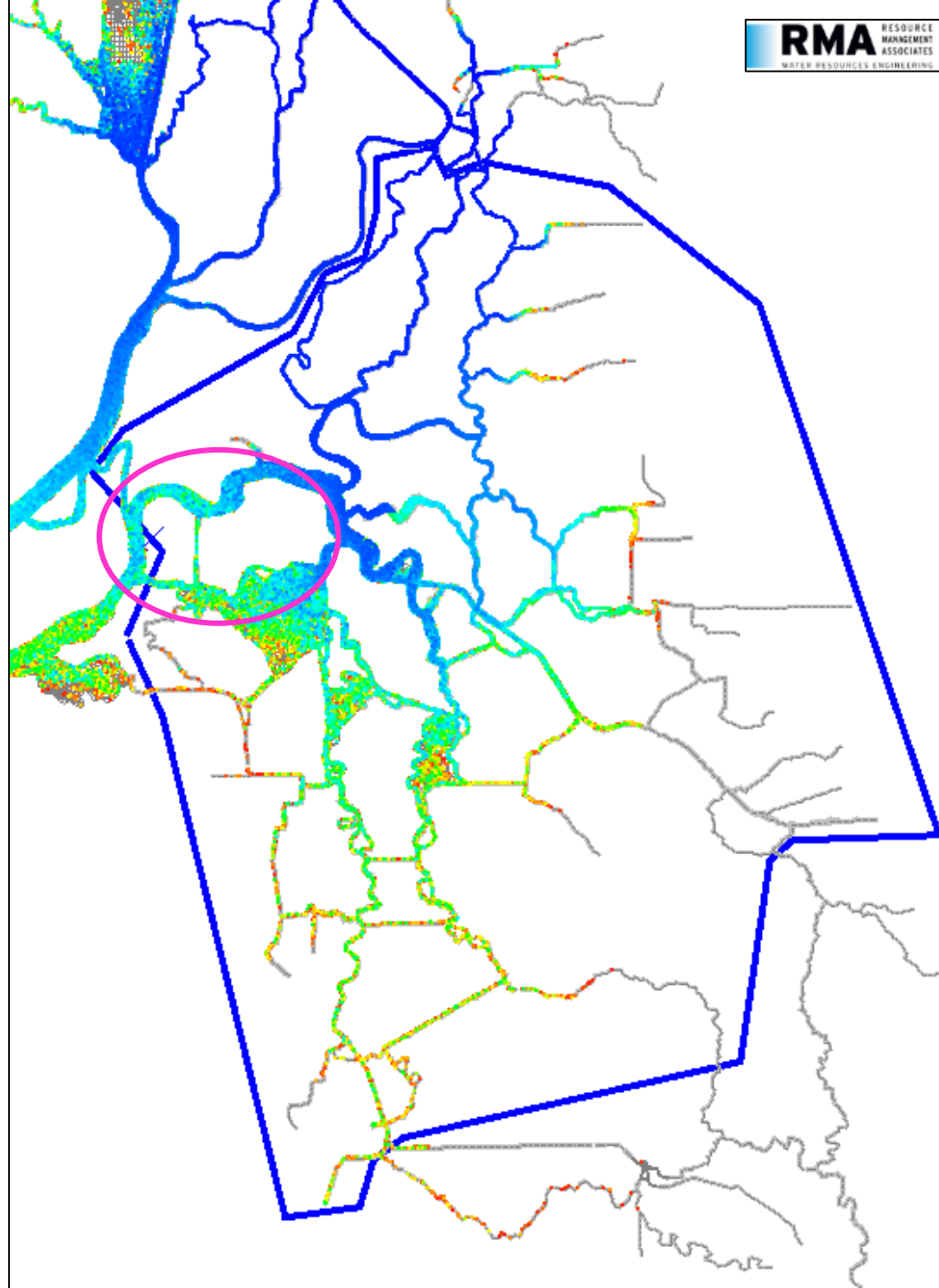
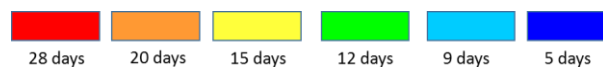
Sept.28, 2008 06:15
Sacramento Source
134,300 Particles Inserted

Age in Central Region

View on incoming tide

Focus on pink outlined area to
compare colors with next slide
to see tidal effect

Color Scale Indicates Approximate Age



Sept.28, 2008 23:45
Sacramento Source
134,300 Particles Inserted

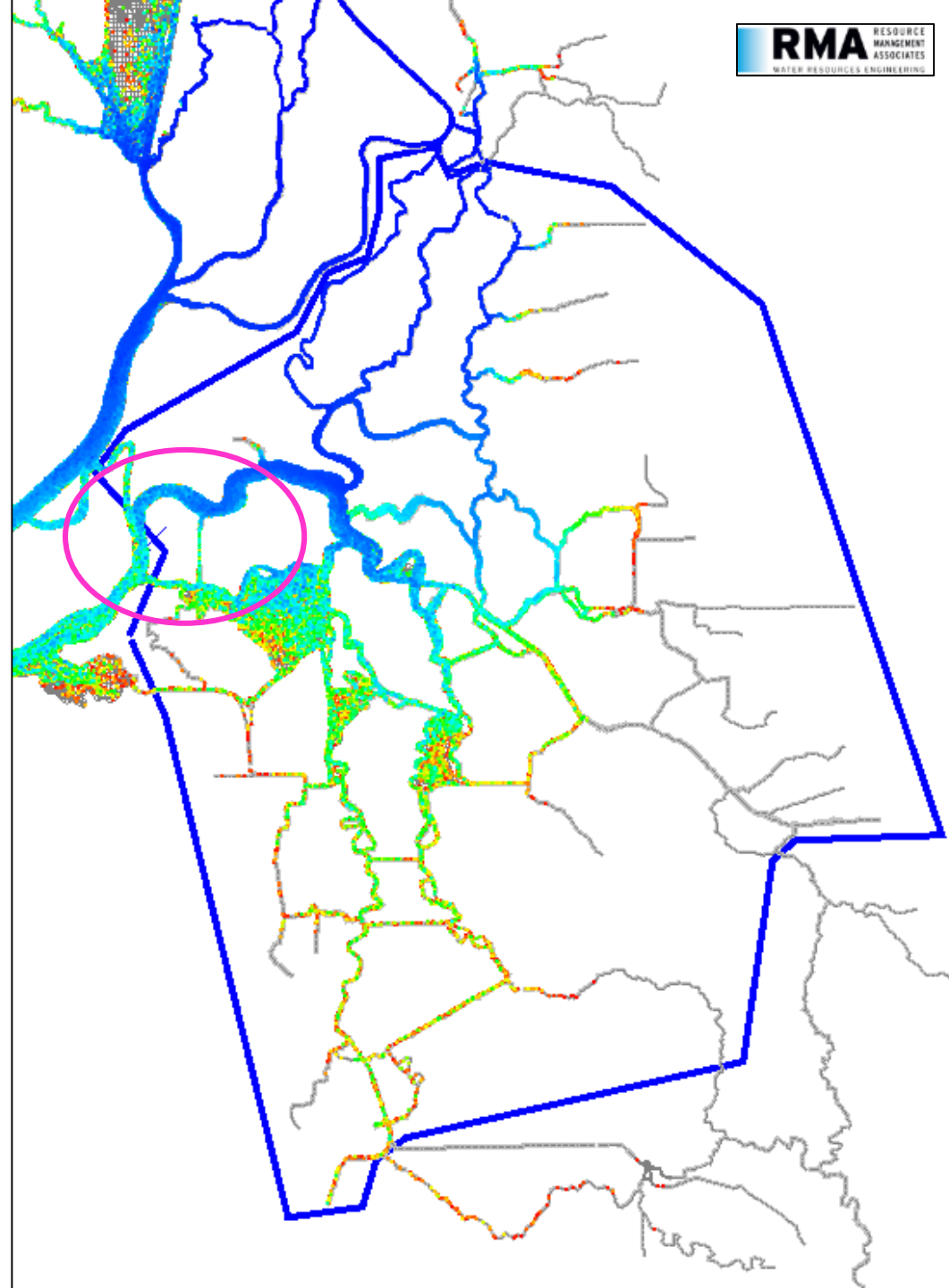
Age in Central Region

View on outgoing tide
Focus on pink outlined area to
compare colors with previous slide
to see tidal effect

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	63%	78%
5 to 10	3%	5%
10 to 15	11%	10%
15 to 20	12%	6%
20 to 25	9%	2%
25 to 28	2%	0%

	Count	Regional %	% of Total
Particles Entering	69813	100%	52%
Particles Staying	52488	75%	39%
Particles Leaving	17325	25%	13%

Color Scale Indicates Approximate Age

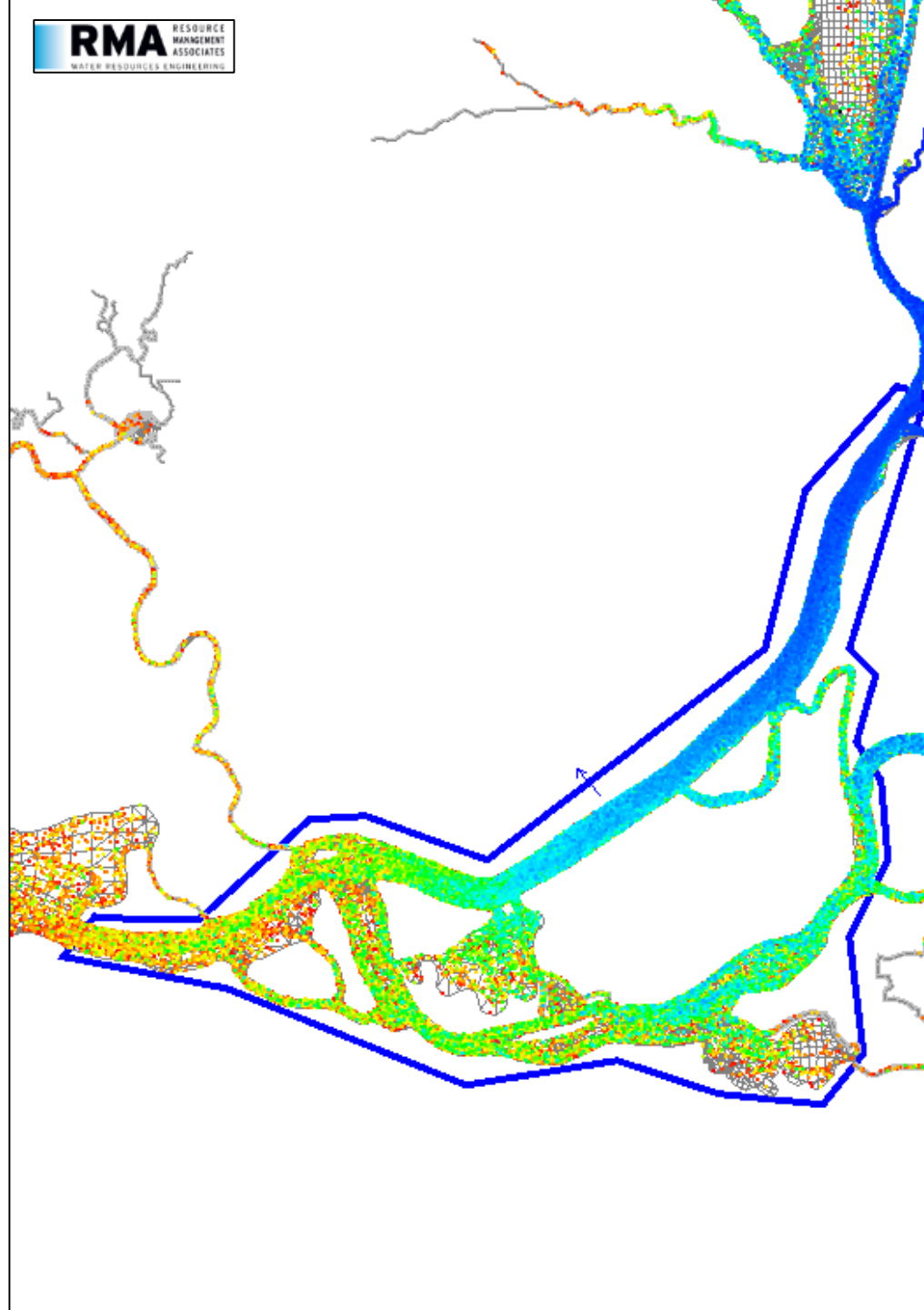


Sept.28, 2008 23:45
 Sacramento Source
 134,300 Particles Inserted
 Age in Confluence Region
 View on outgoing tide

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	11%	37%
5 to 10	35%	40%
10 to 15	18%	13%
15 to 20	18%	7%
20 to 25	14%	3%
25 to 28	4%	0%

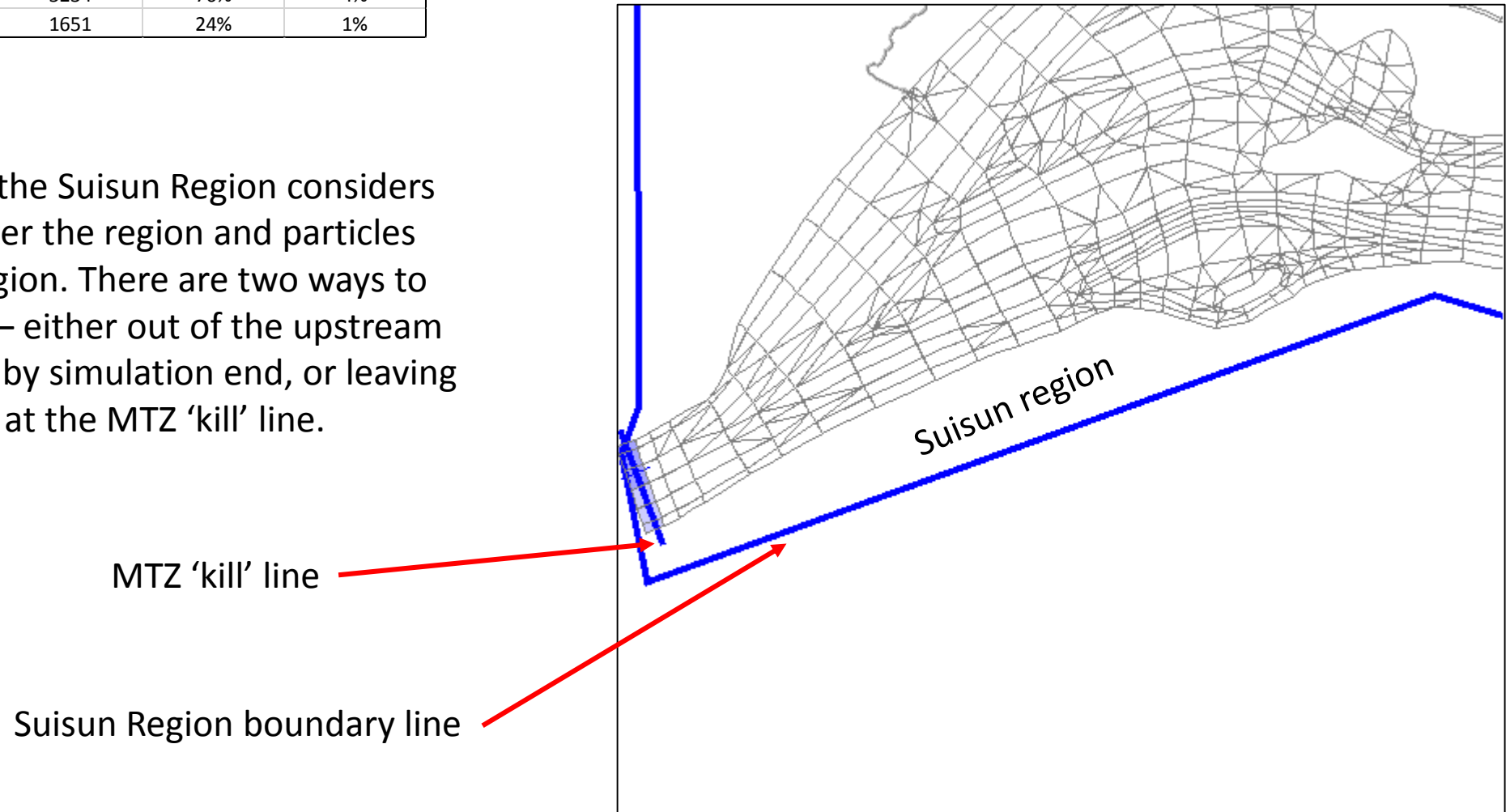
	Count	Regional %	% of Total
Particles Entering	58047	100%	43%
Particles Staying	772	1%	1%
Particles Leaving	15477	27%	12%

Color Scale Indicates Approximate Age



	Count	Regional %	% of Total
Particles Entering	6885	100%	5%
Particles Exiting Upstream	5234	76%	4%
Particles Exiting MTZ	1651	24%	1%

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.

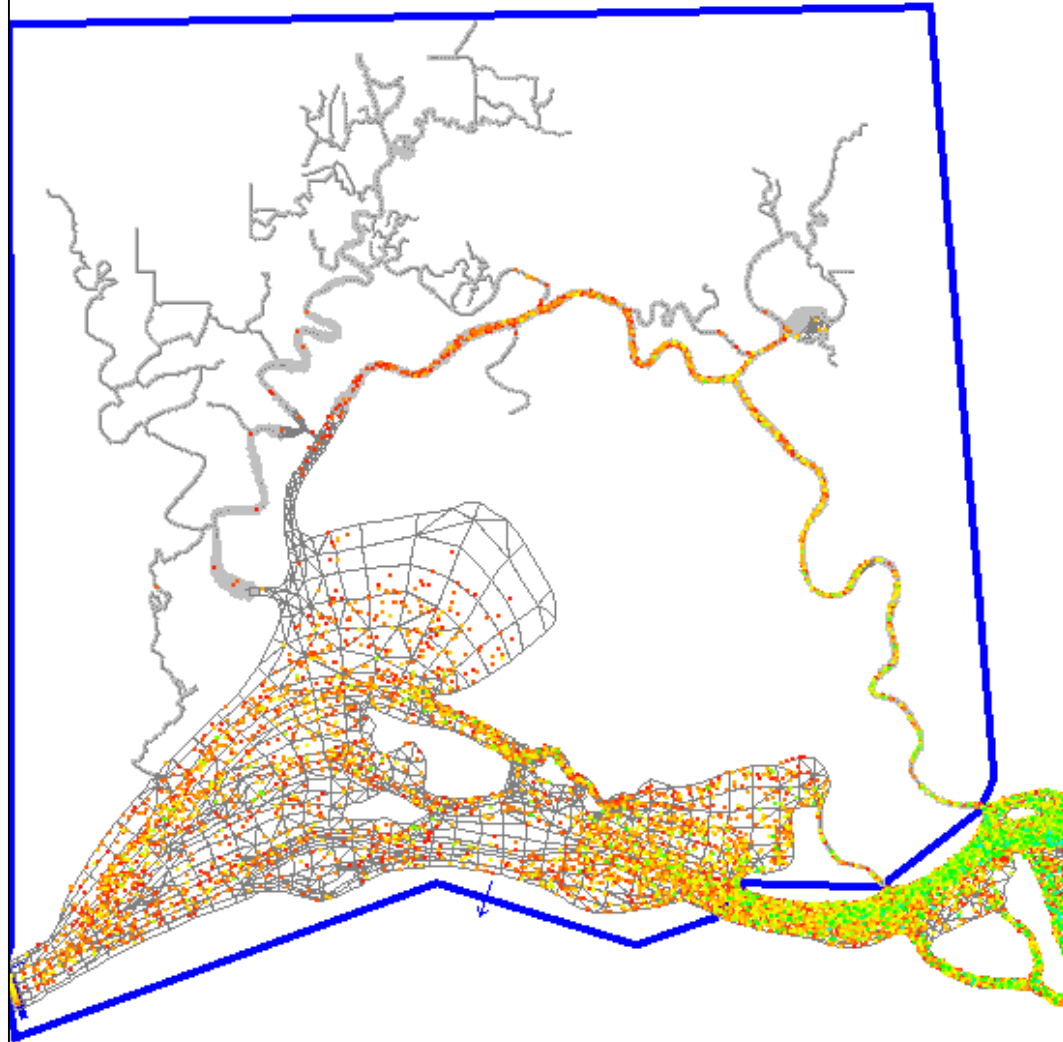


Sept.28, 2008 21:45
Sacramento Source
134,300 Particles Inserted

Age in Suisun Region

View on outgoing tide

Color Scale Indicates Approximate Age



Sept.28, 2008 23:45
Sacramento Source
134,300 Particles Inserted

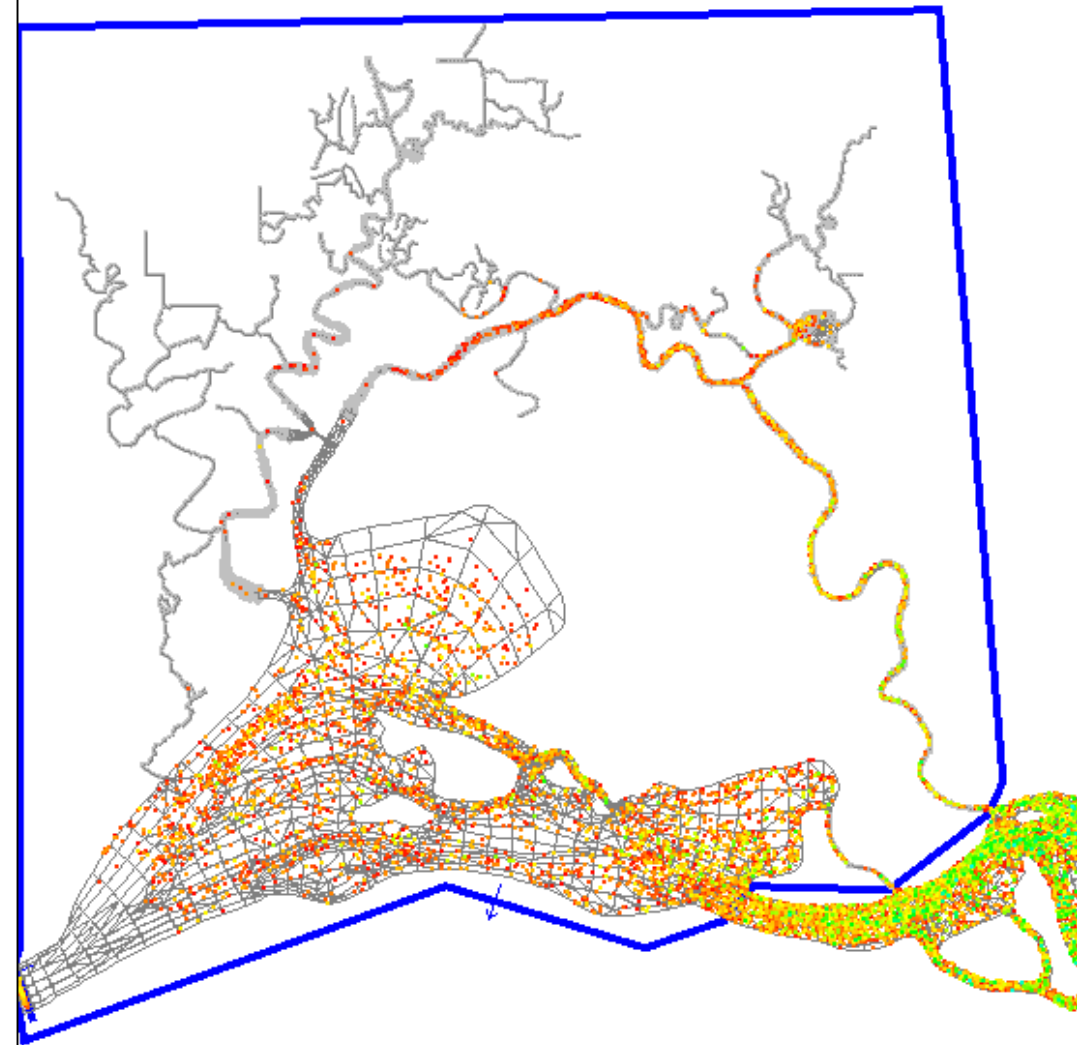
Age in Suisun Region

View on start of incoming tide

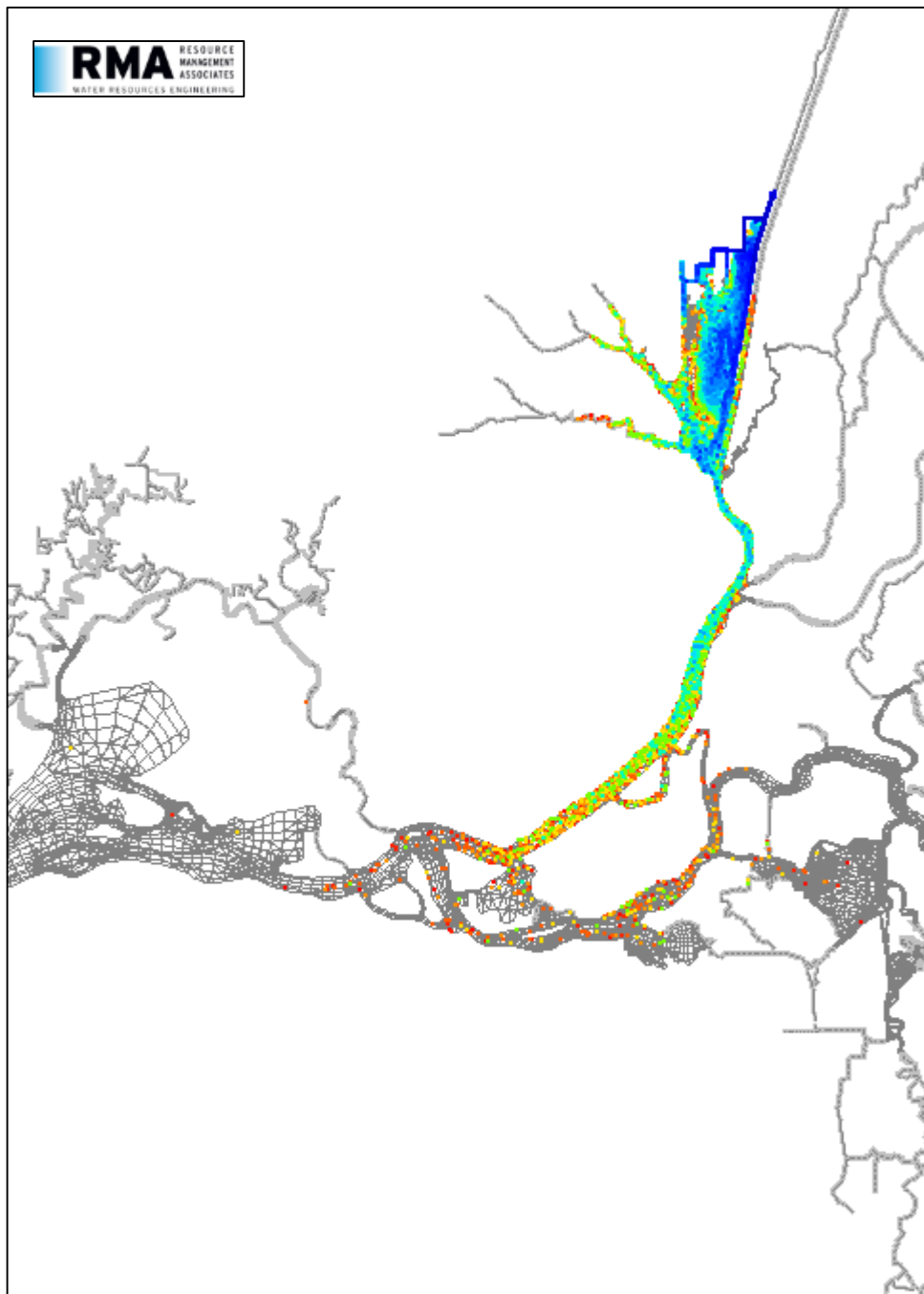
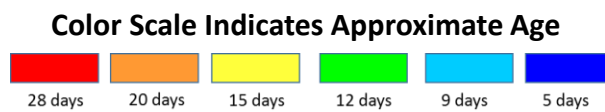
Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	0%	0%
10 to 15	3%	4%
15 to 20	37%	45%
20 to 25	48%	43%
25 to 28	13%	8%

	Count	Regional %	% of Total
Particles Entering	6885	100%	5%
Particles Exiting Upstream	5234	76%	4%
Particles Exiting MTZ	1651	24%	1%

Color Scale Indicates Approximate Age



Sept.28, 2008 23:45
Yolo Source
134,300 Particles Inserted
Age in Full Delta

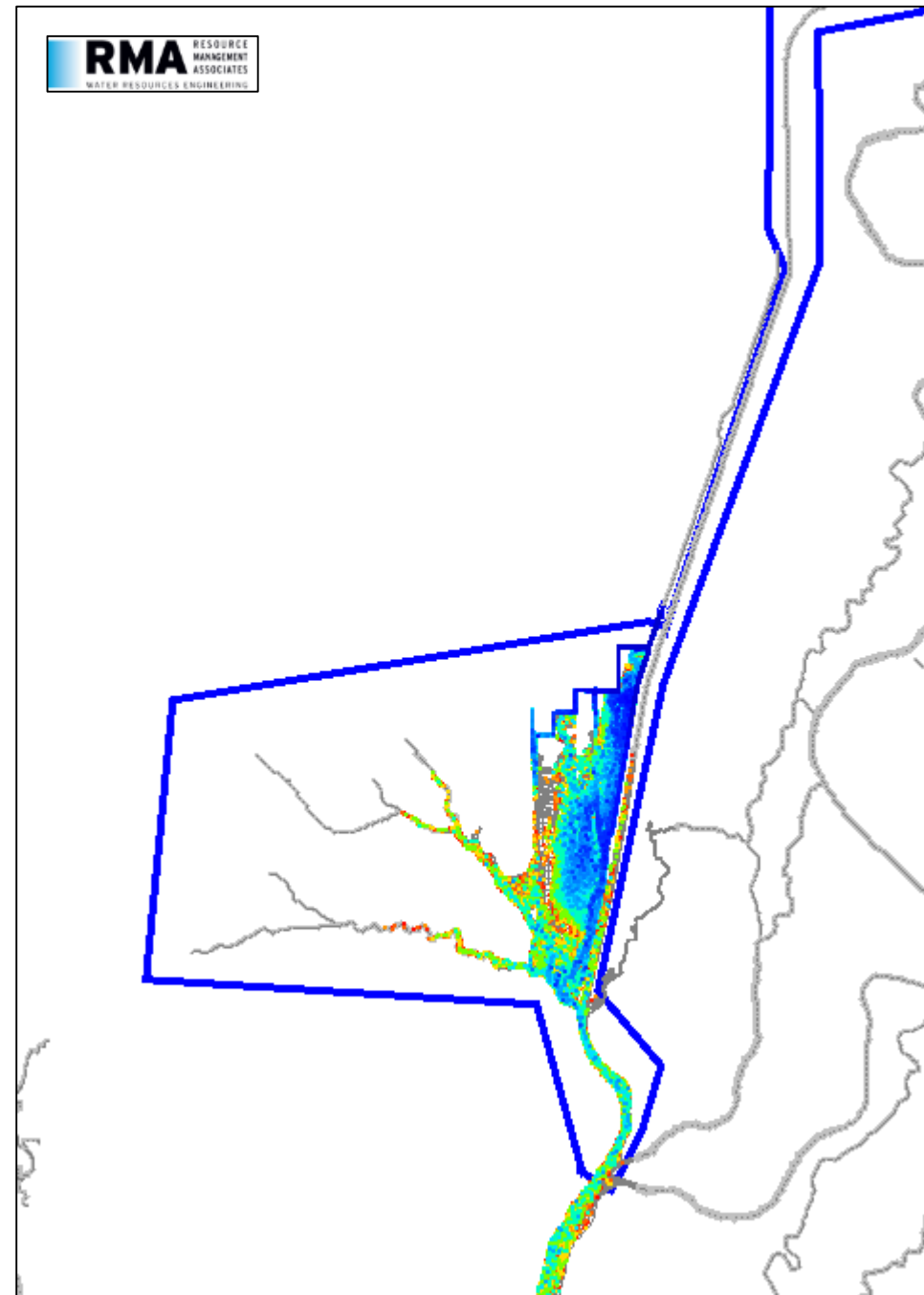


Sept.28, 2008 23:45
Yolo Source
134,300 Particles Inserted
Age in N. Delta Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	47%	90%
5 to 10	34%	7%
10 to 15	10%	0%
15 to 20	3%	0%
20 to 25	2%	0%
25 to 28	3%	2%

	Count	Regional %	% of Total
Particles Entering	134300	100%	100%
Particles Leaving	2964	2%	2%
Particles Staying	130905	97%	97%

Color Scale Indicates Approximate Age

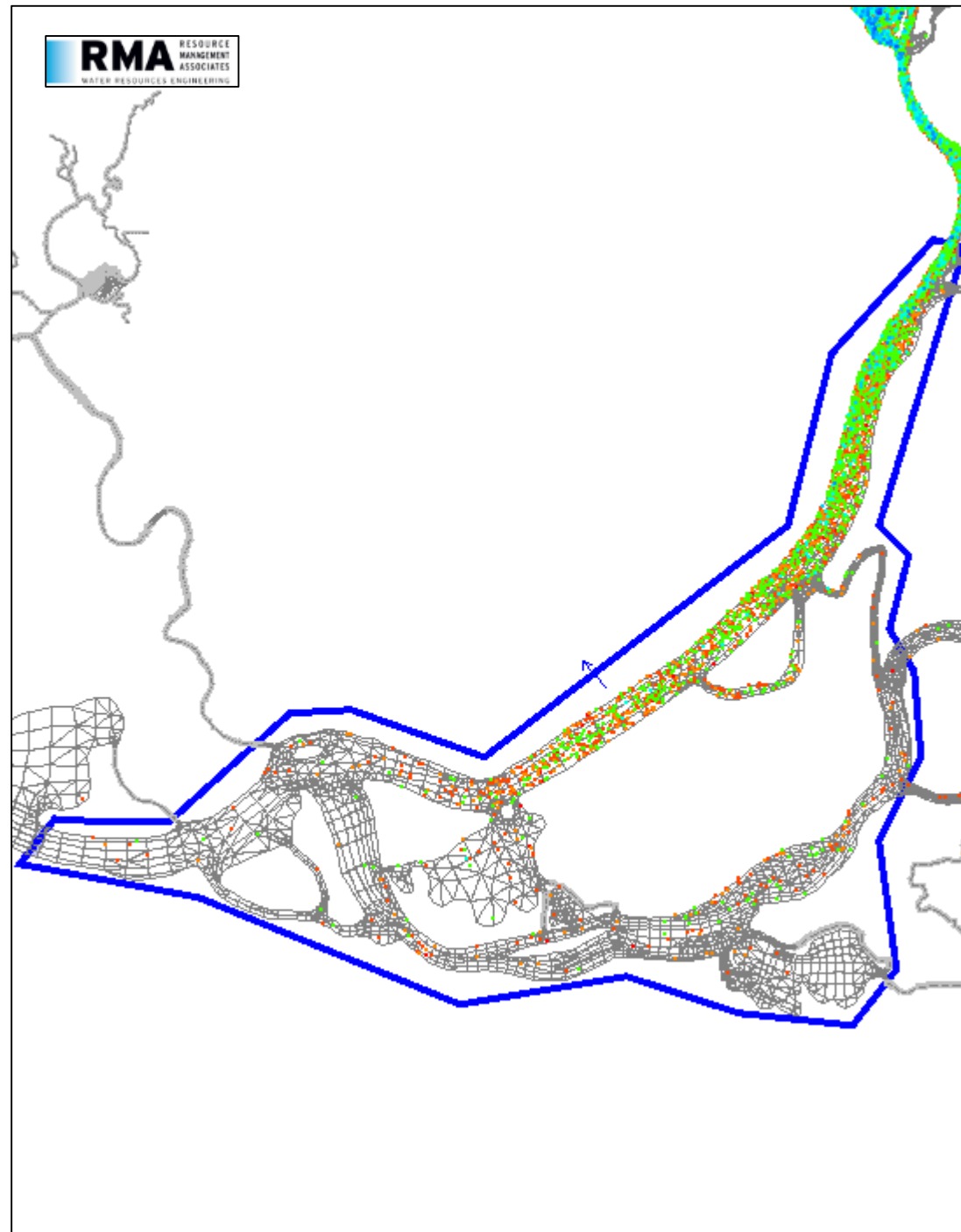


Sept.28, 2008 23:45
 Yolo Source
 134,300 Particles Inserted
 Age in Confluence Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	1%	1%
10 to 15	6%	12%
15 to 20	27%	33%
20 to 25	42%	40%
25 to 28	23%	14%

	Count	Regional %	% of Total
Particles Entering	3765	100%	3%
Particles Staying	730	19%	1%
Particles Leaving	3035	81%	2%

Color Scale Indicates Approximate Age



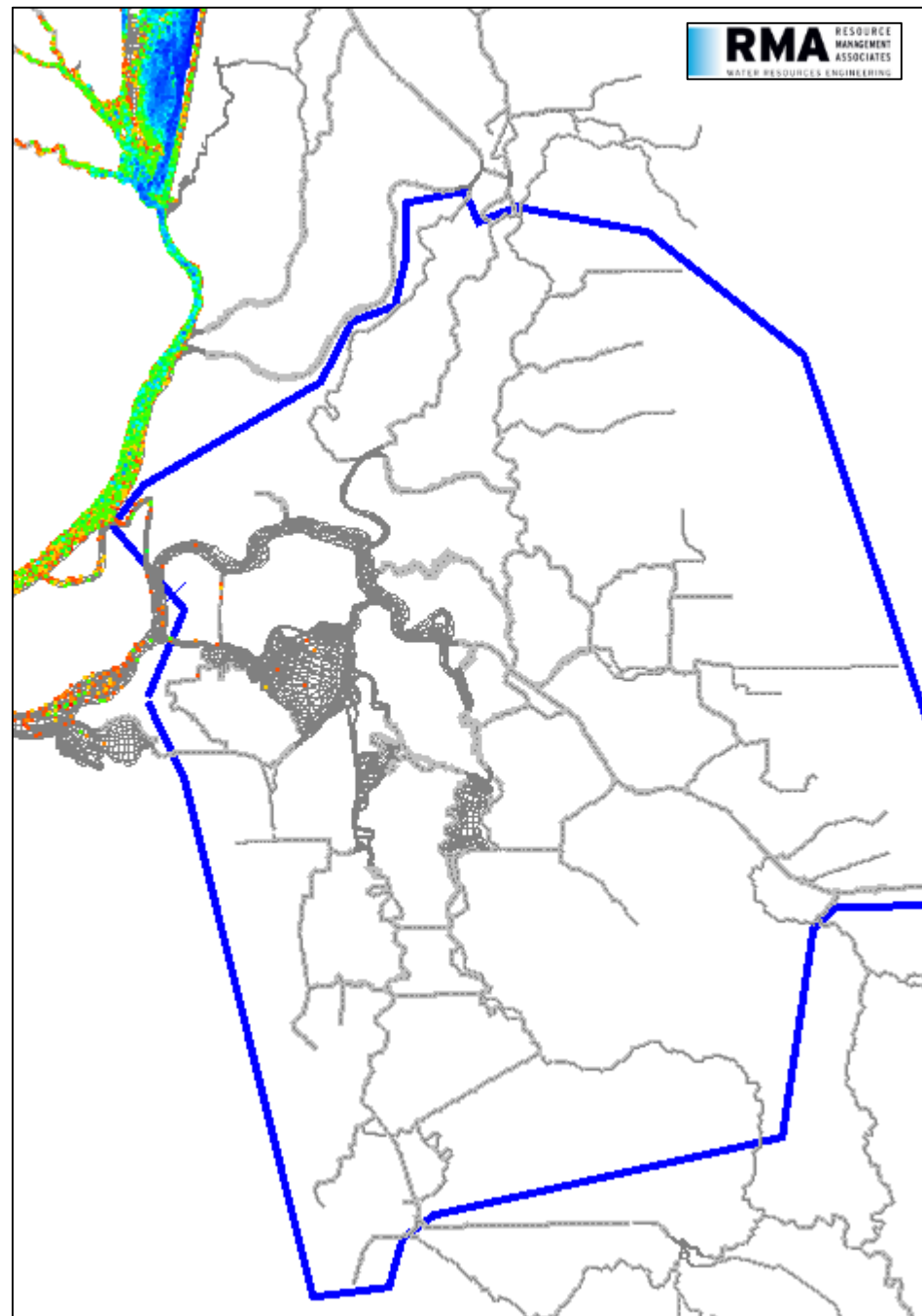
Sept.28, 2008 18:15
 Yolo Source
 134,300 Particles Inserted

Age in Central 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	1%	2%
15 to 20	17%	21%
20 to 25	45%	54%
25 to 28	37%	23%

	Count	Regional %	% of Total
Particles Entering	313	100%	0%
Particles Staying	282	90%	0%
Particles Leaving	31	10%	0%

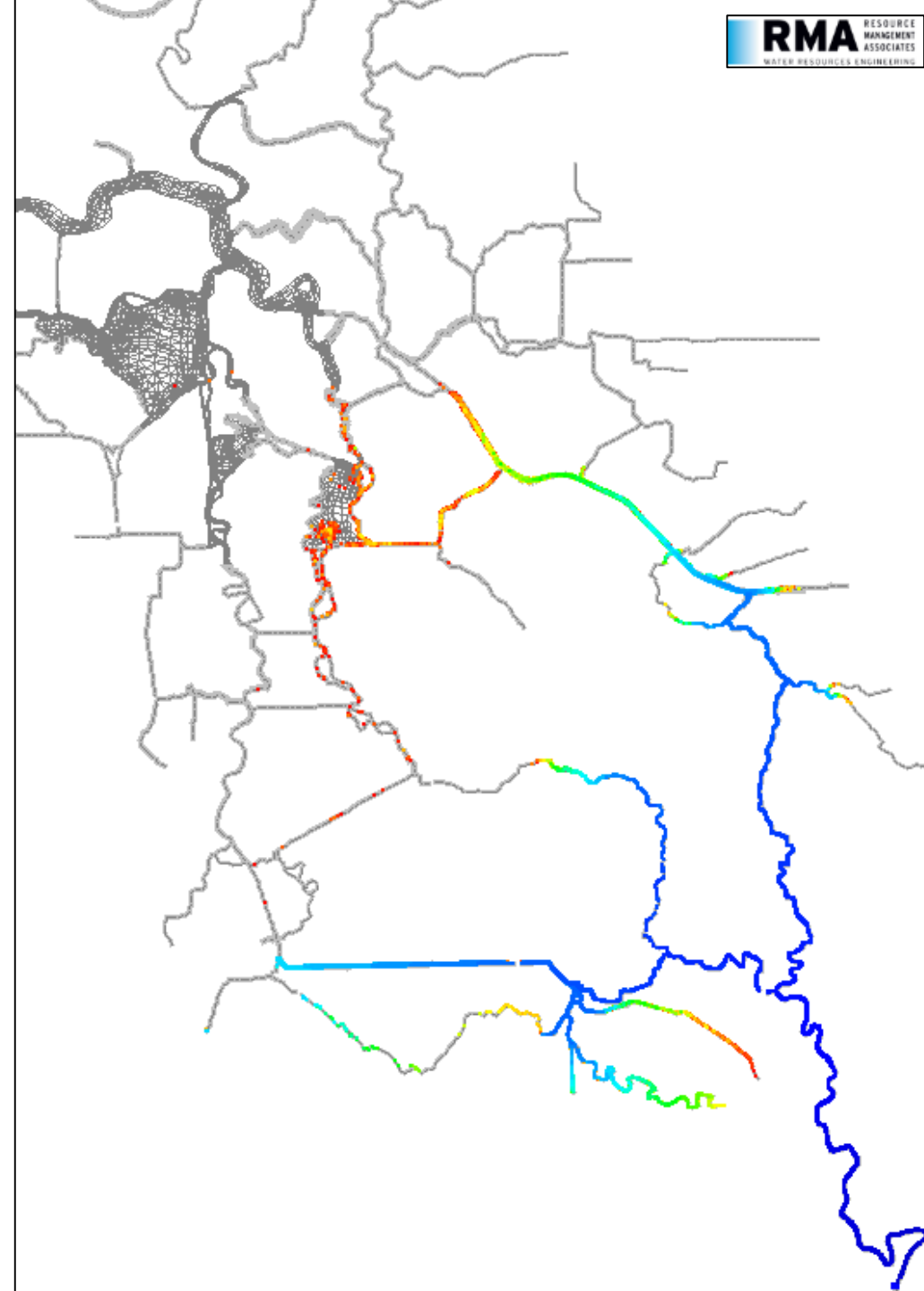
Color Scale Indicates Approximate Age



Sept.28, 2008 23:45
San Joaquin Source
134,300 Particles Inserted

Age in Full Delta

Color Scale Indicates Approximate Age



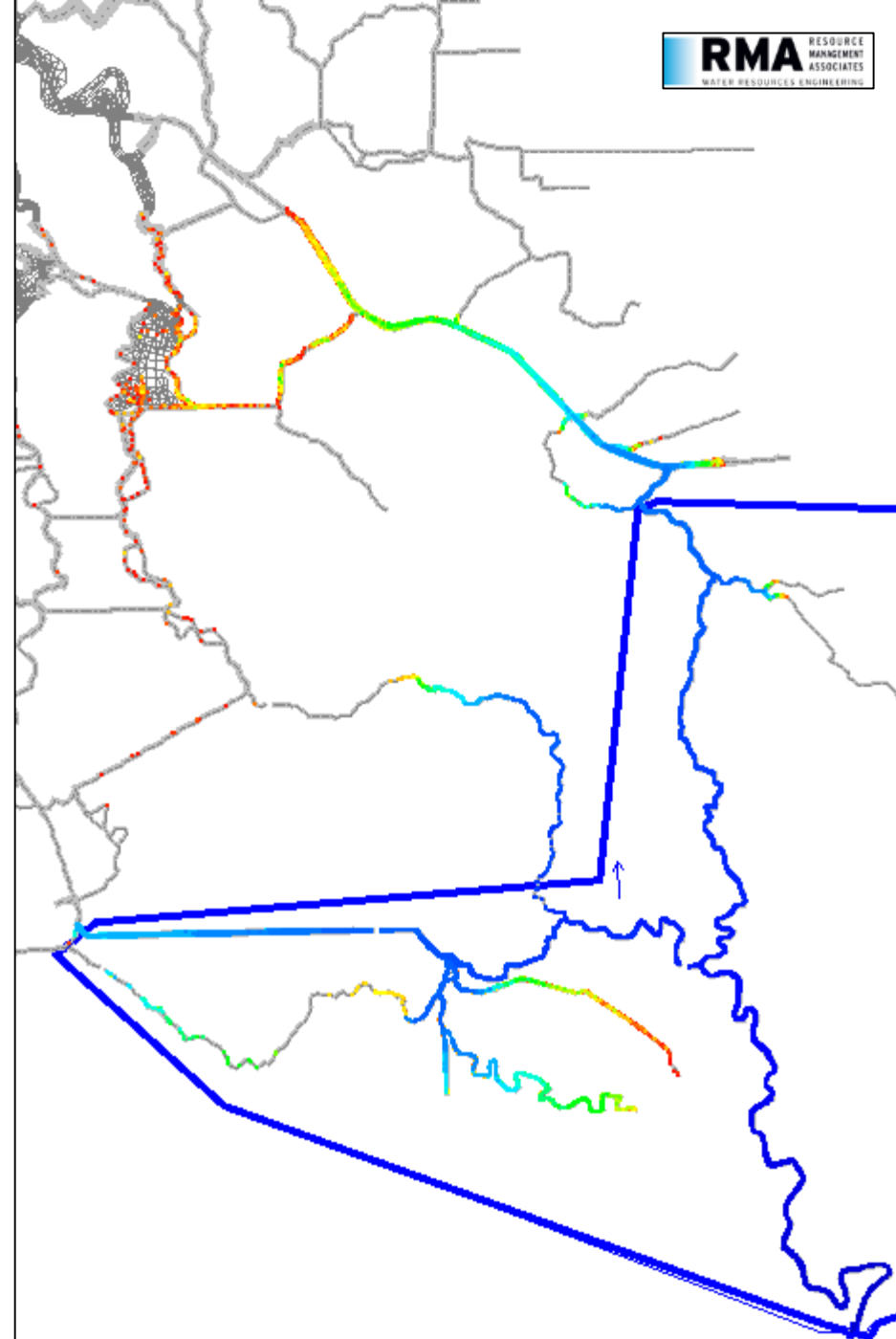
Sept.28, 2008 23:45
 San Joaquin Source
 134,300 Particles Inserted

Age in S. Delta

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	15%	62%
5 to 10	33%	1%
10 to 15	15%	0%
15 to 20	0%	0%
20 to 25	0%	0%
25 to 28	37%	37%

	Count	Regional %	% of Total
Particles Entering	134300	100%	100%
Particles Staying	50151	37%	37%
Particles Leaving	84149	63%	63%

Color Scale Indicates Approximate Age



Sept.28, 2008 23:45
San Joaquin Source
134,300 Particles Inserted

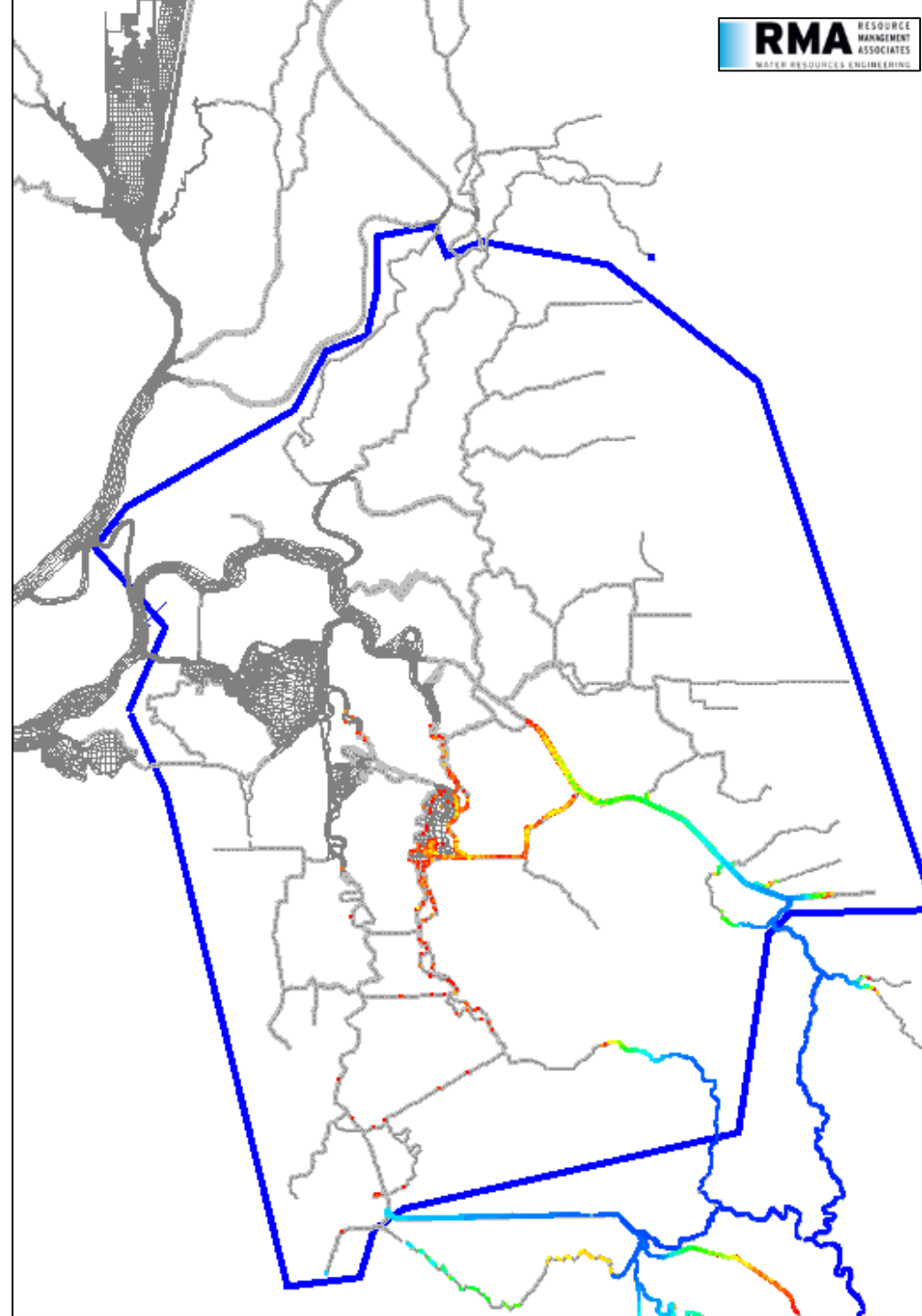
Age in Central Region

Most particles exported at CVP

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	5%	9%
5 to 10	59%	60%
10 to 15	36%	30%
15 to 20	1%	1%
20 to 25	0%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	83926	100%	62%
Particles Staying	4200	5%	3%
Particles Leaving	79726	95%	59%

Color Scale Indicates Approximate Age

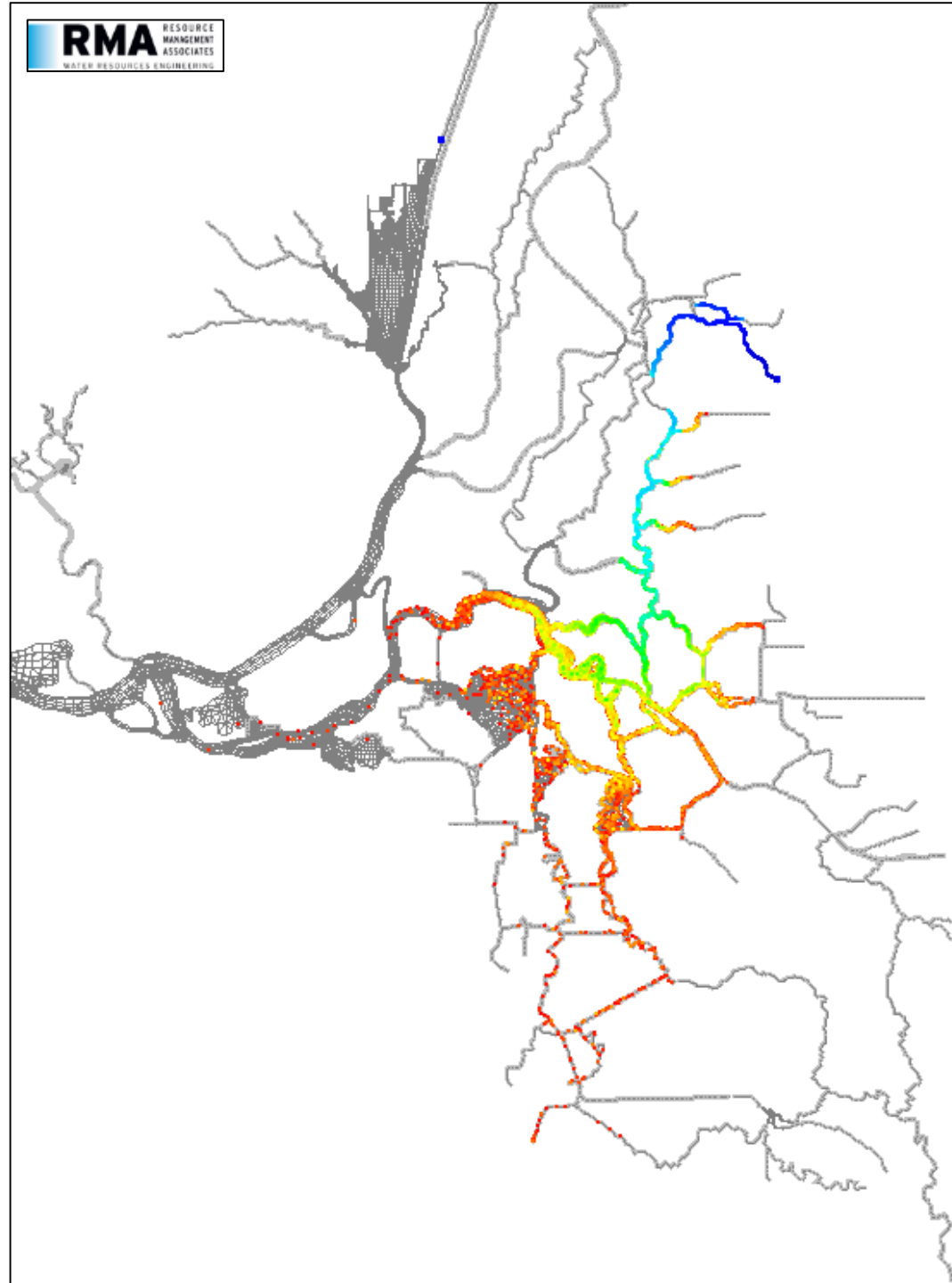


Sept.28, 2008 23:45
Mokelumne Source
134,300 Particles Inserted

Age in Full Delta

Note: Cosumnes particles were not
inserted as flows were very low

Color Scale Indicates Approximate Age



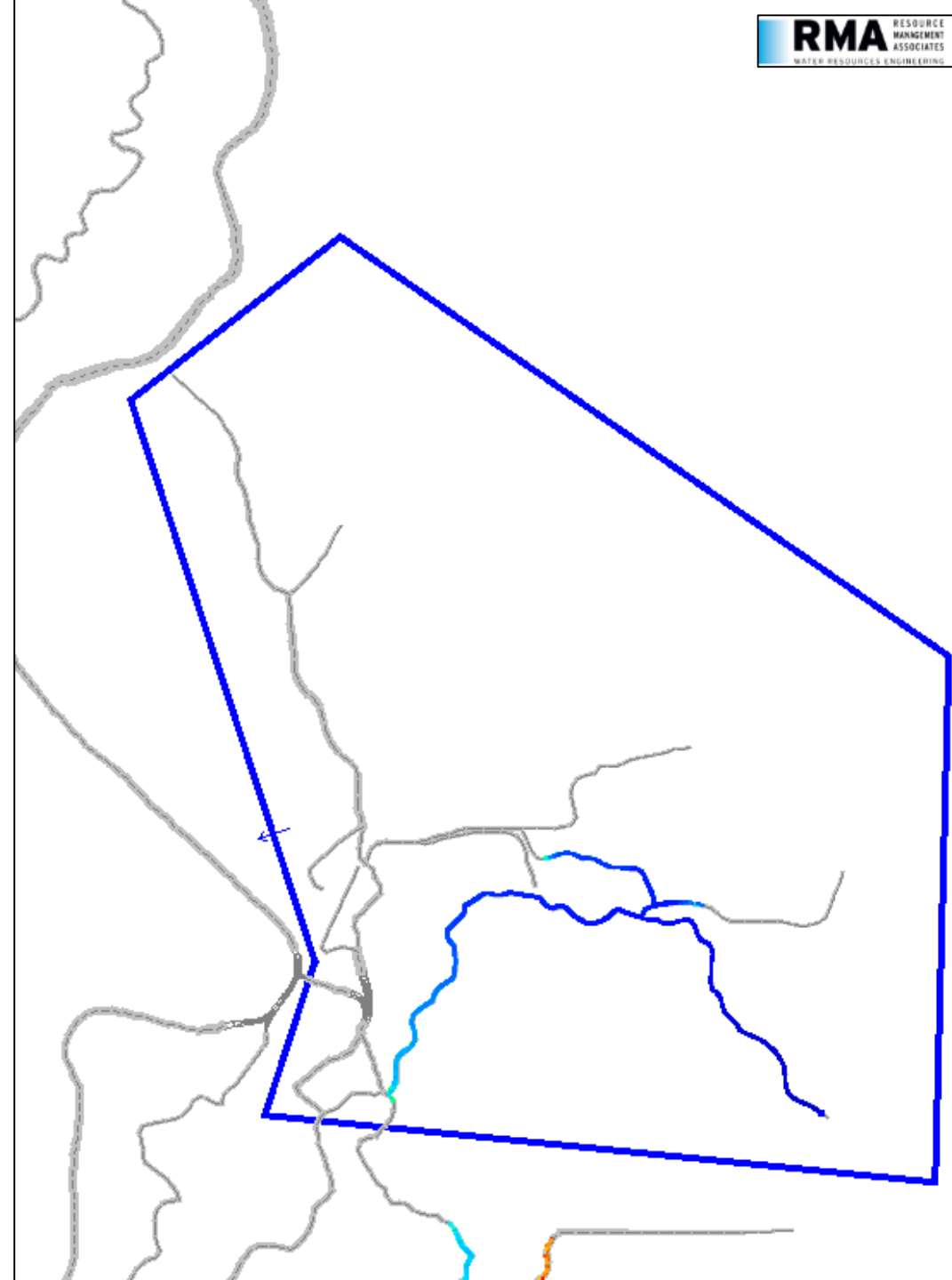
Sept.28, 2008 23:45
Mokelumne Source
134,300 Particles Inserted

Age in Eastside Region of Mokelumne Particles

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	100%
5 to 10	25%	0%
10 to 15	64%	0%
15 to 20	10%	0%
20 to 25	1%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	134300	100%	100%
Particles Leaving	66781	100%	50%

Color Scale Indicates Approximate Age

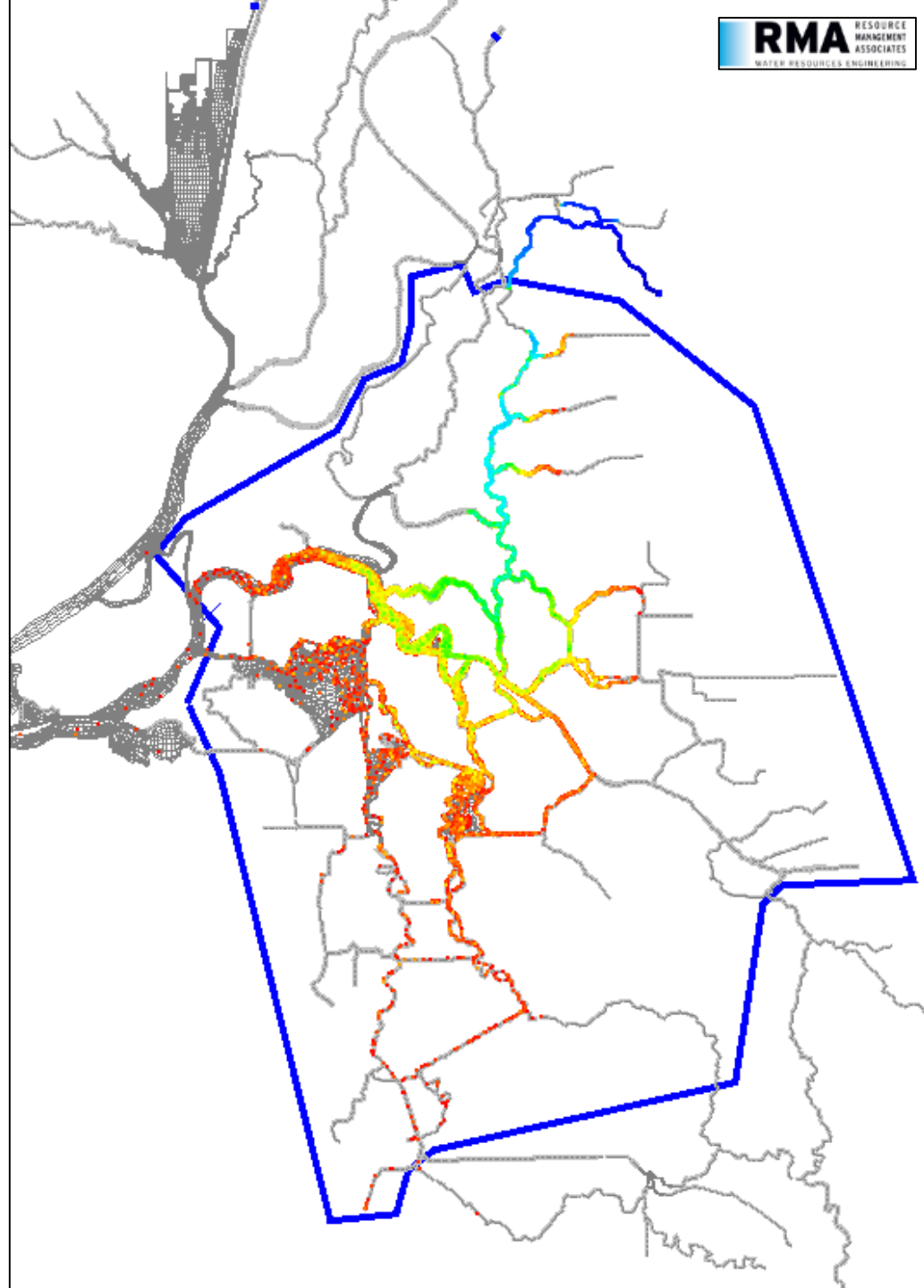


Sept.28, 2008 23:45
Moke Source
134,300 Particles Inserted
Age in Central Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
>0 to 5	0%	0%
5 to 10	26%	27%
10 to 15	63%	63%
15 to 20	10%	10%
20 to 25	1%	1%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	70310	100%	52%
Particles Staying	67582	96%	50%
Particles Leaving	2728	4%	2%

Color Scale Indicates Approximate Age



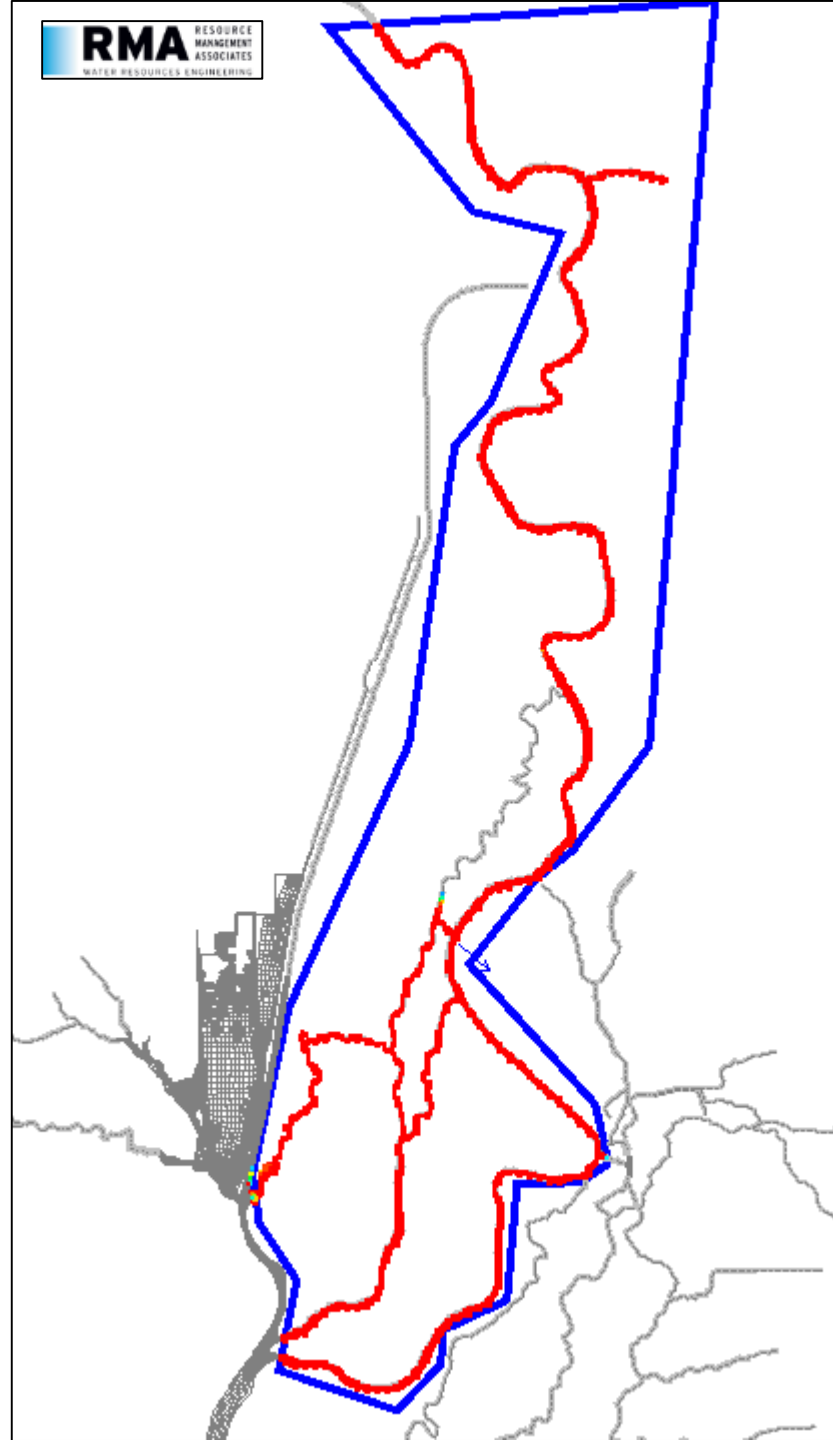
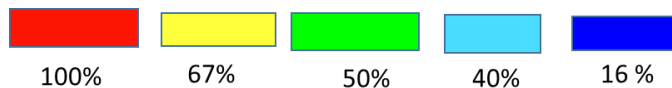
Sept 28, 2008 23:45
Sac Region Fate Map
99817 Particles inserted

(cell size = 100, 100,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	96%
5 to 10	0%
10 to 15	0%
15 to 20	0%
20 to 25	0%
25-28	0%
>28	4%

	Count	% of Total
Particles Staying	3938	4%
Particles Leaving	95879	96%

Color Scale Shows % of Parcels Exiting Local Cell



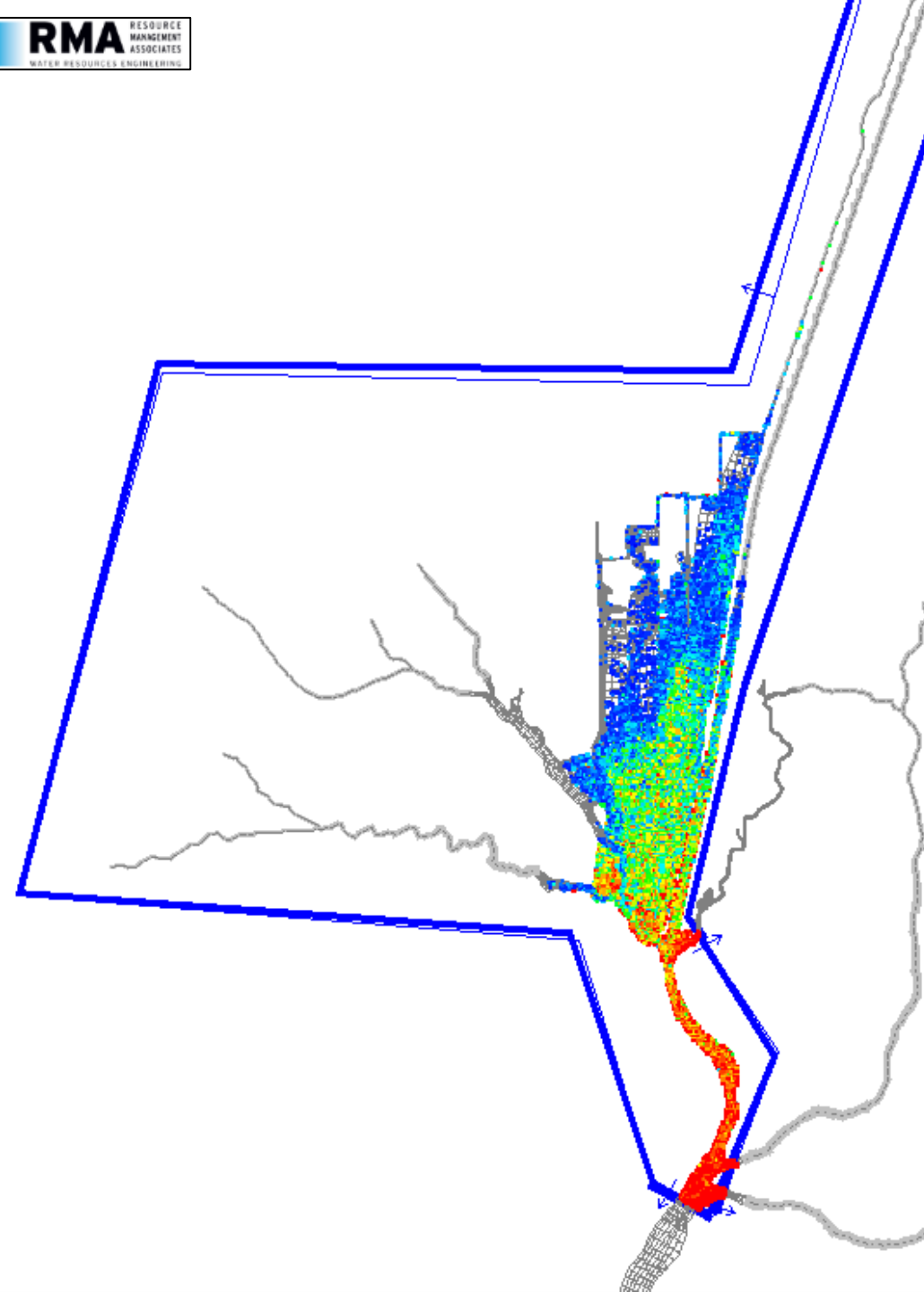
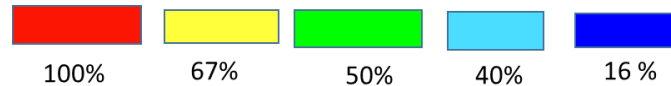
Sept 28, 2008 23:45
N. Delta Region Fate Map
148,441 Particles inserted

(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	10%
5 to 10	5%
10 to 15	6%
15 to 20	4%
20 to 25	4%
25-28	2%
>28	70%

	Count	% of Total
Particles Staying	103235	70%
Particles Leaving	45206	30%

Color Scale Shows % of Parcels Exiting Local Cell



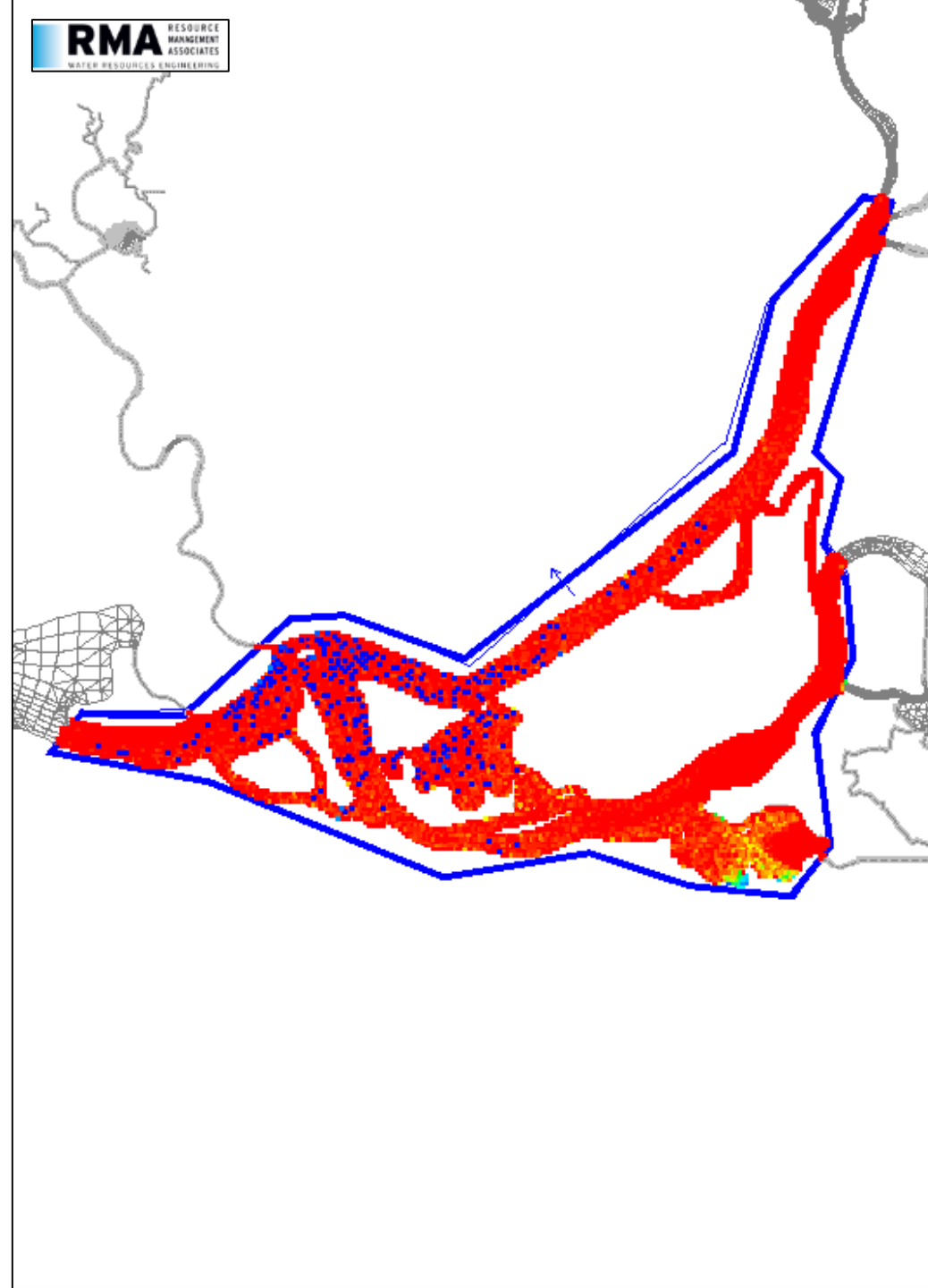
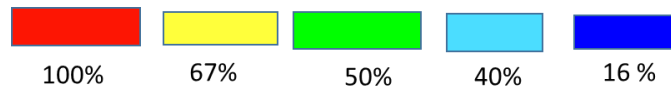
Sept 28, 2008 23:45
Confluence Region Fate Map
149,237 Particles inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	50%
5 to 10	23%
10 to 15	13%
15 to 20	6%
20 to 25	3%
25-28	1%
>28	4%

	Count	% of Total
Particles Staying	5658	4%
Particles Leaving	143579	96%

Color Scale Shows % of Parcels Exiting Local Cell



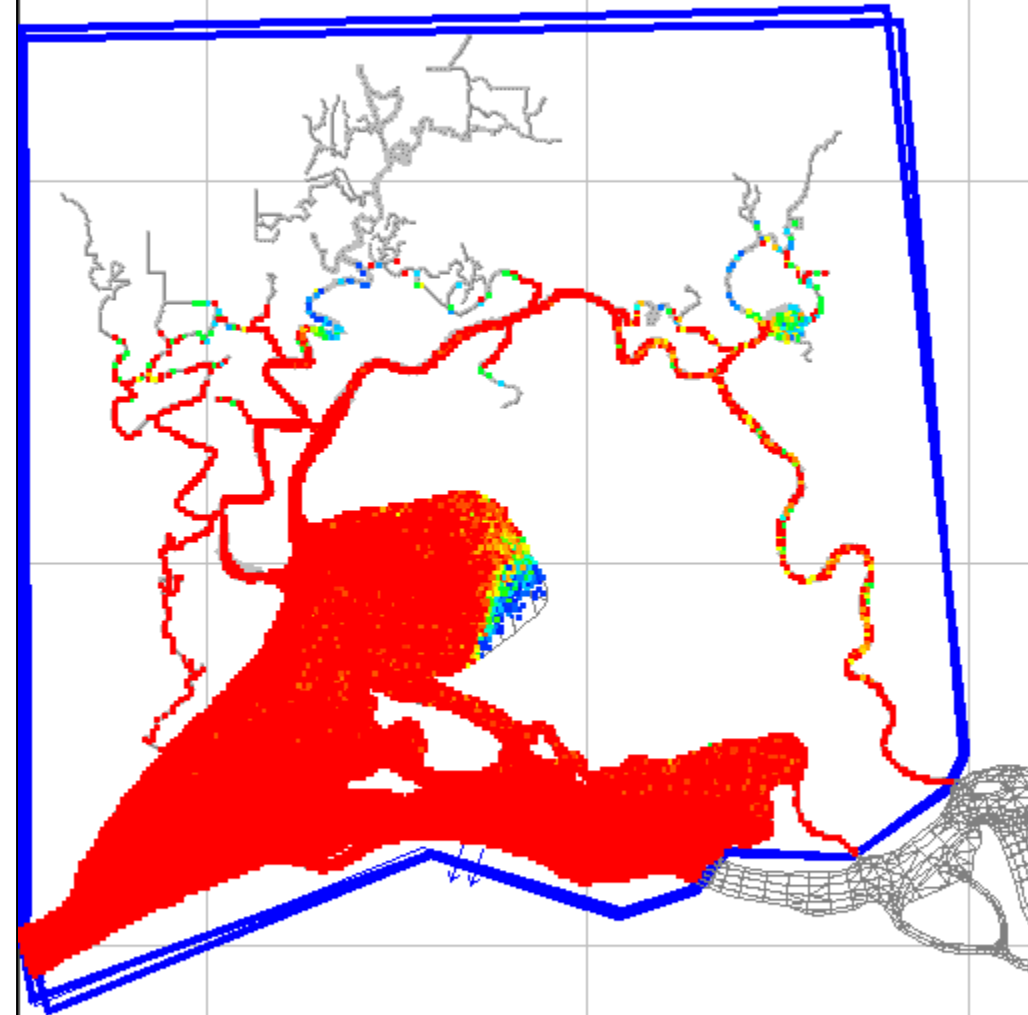
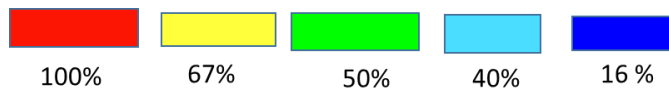
Sept 28, 2008 23:45
Suisun Region Fate Map
99437 Particles inserted

(cell size = 100, 100,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	66%
5 to 10	17%
10 to 15	5%
15 to 20	3%
20 to 25	2%
25-28	1%
>28	6%

	Count	% of Total
Particles Staying	5791	6%
Particles Leaving	93646	94%

Color Scale Shows % of Parcels Exiting Local Cell



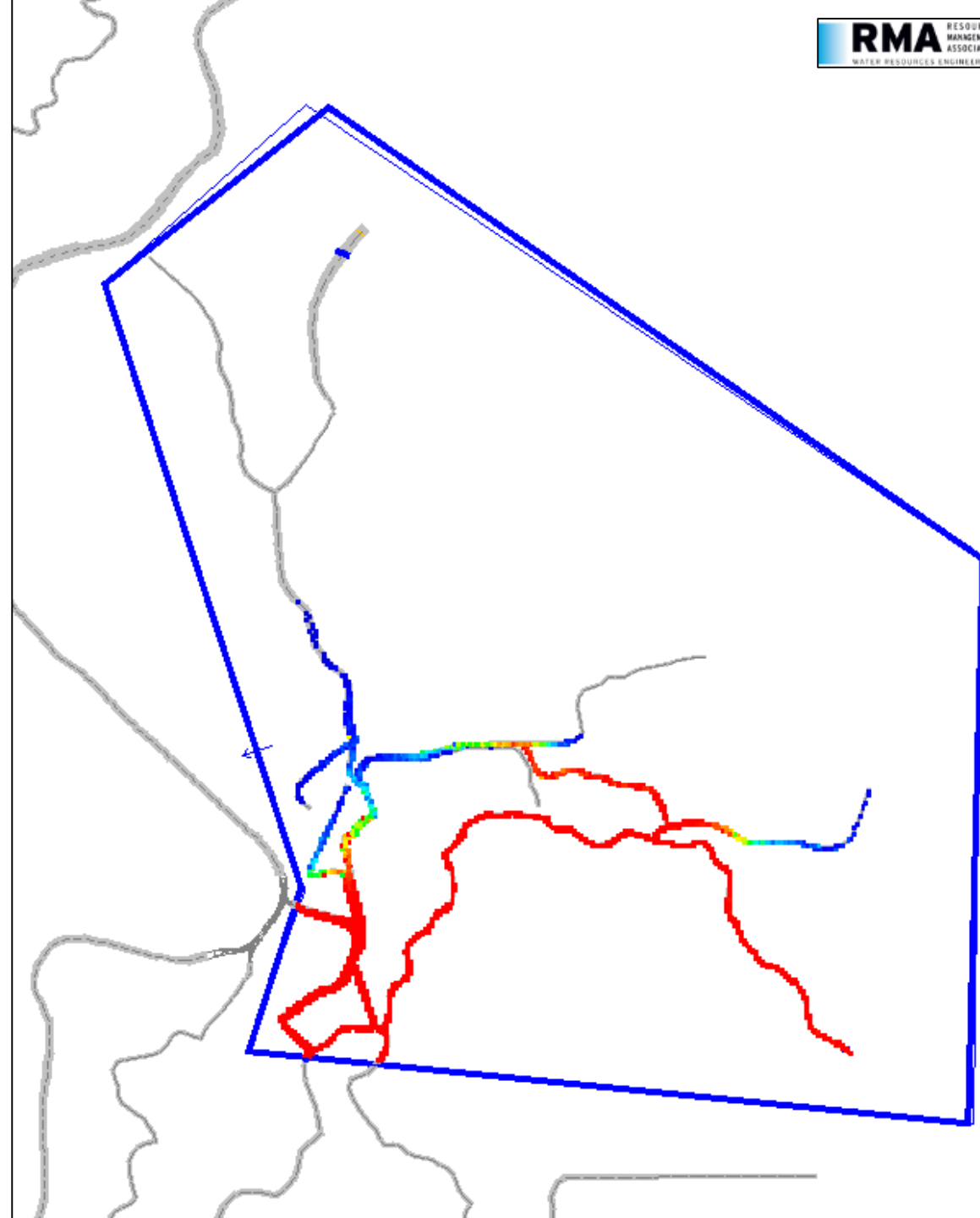
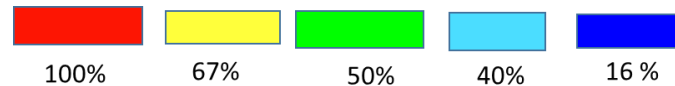
Sept 28, 2008 23:45
Eastside Region Fate Map
149,905 Particles inserted

(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	31%
5 to 10	5%
10 to 15	4%
15 to 20	2%
20 to 25	2%
25-28	1%
>28	55%

	Count	% of Total
Particles Staying	82797	55%
Particles Leaving	67108	45%

Color Scale Shows % of Parcels Exiting Local Cell



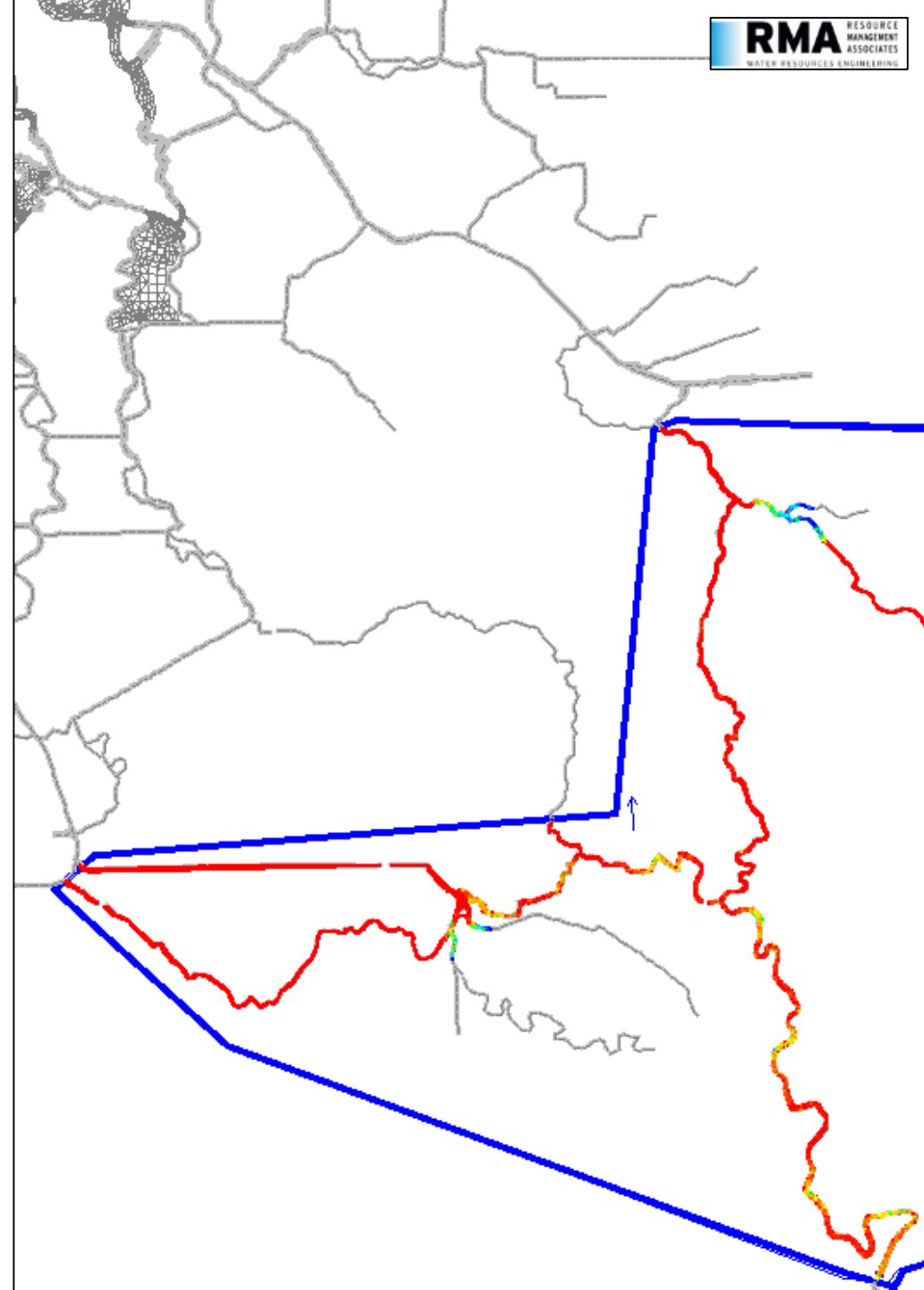
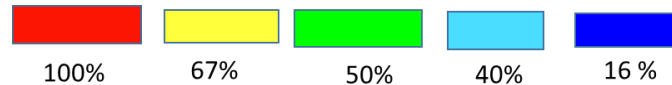
Sept 28, 2008 23:45
S. Delta Region Fate Map
149,828 Particles inserted

(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	38%
5 to 10	39%
10 to 15	6%
15 to 20	0%
20 to 25	0%
25-28	0%
>28	16%

	Count	% of Total
Particles Staying	24437	16%
Particles Leaving	125391	84%

Color Scale Shows % of Parcels Exiting Local Cell



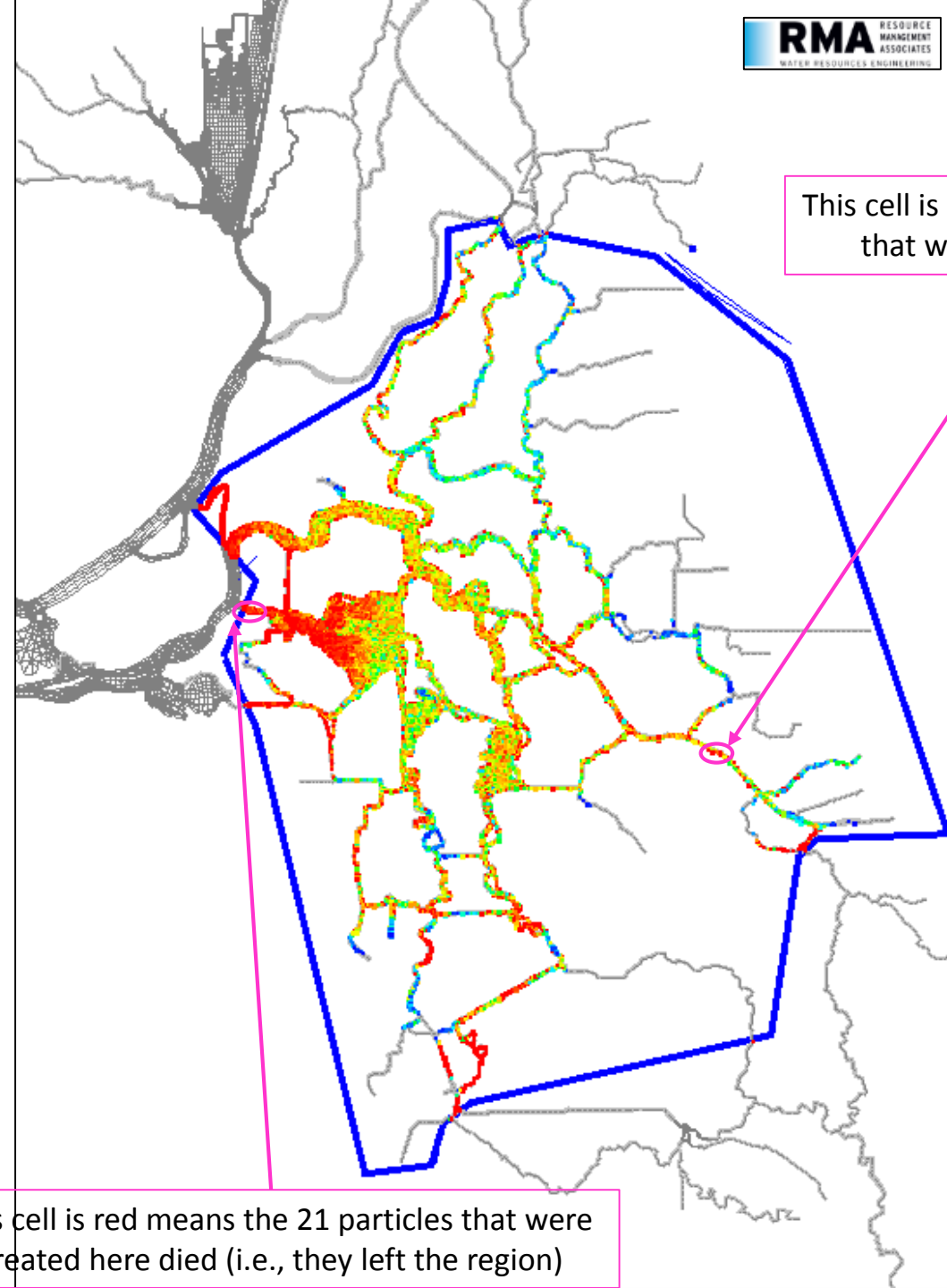
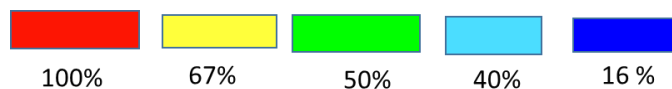
Sept 28, 2008 23:45
Central Region Fate Map
148,802 Particles inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	22%
5 to 10	17%
10 to 15	10%
15 to 20	9%
20 to 25	6%
25 to 28	3%
>28	33%

	Count	% of Total
Particles Staying	48594	33%
Particles Leaving	100208	67%

Color Scale Shows % of Parcels Exiting Local Cell



This cell is red means the 1 particle that was created here died

This cell is red means the 21 particles that were created here died (i.e., they left the region)

DUPLICATE SLIDE

Sept 28, 2008 23:45

Central Region Fate Map

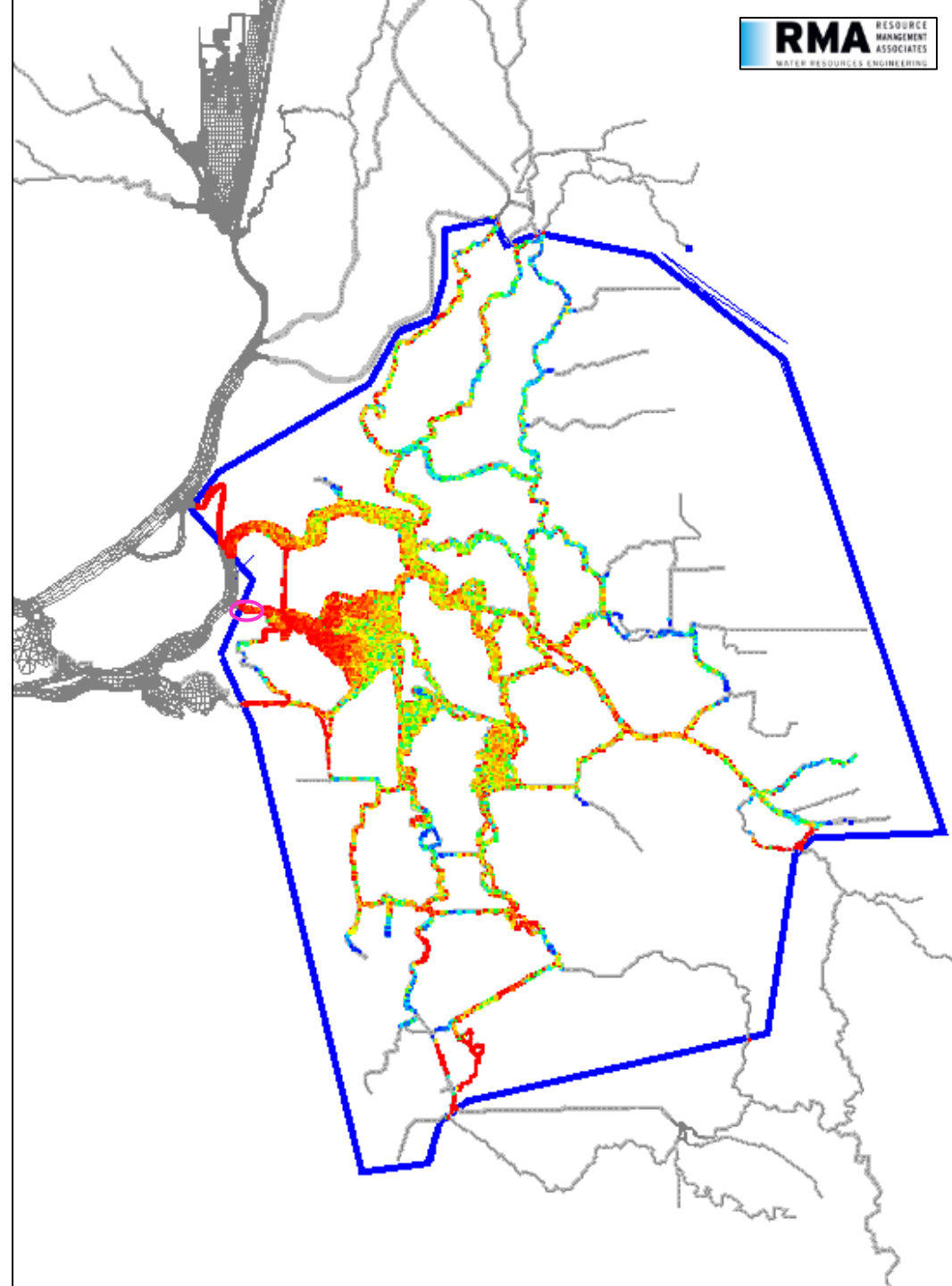
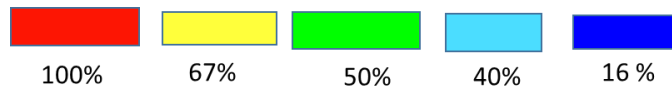
148,802 Particles inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	22%
5 to 10	17%
10 to 15	10%
15 to 20	9%
20 to 25	6%
25 to 28	3%
>28	33%

	Count	% of Total
Particles Staying	48594	33%
Particles Leaving	100208	67%

Color Scale Shows % of Parcels Exiting Local Cell



Sept 28, 2008 23:45

Central-Upper Region Fate Map

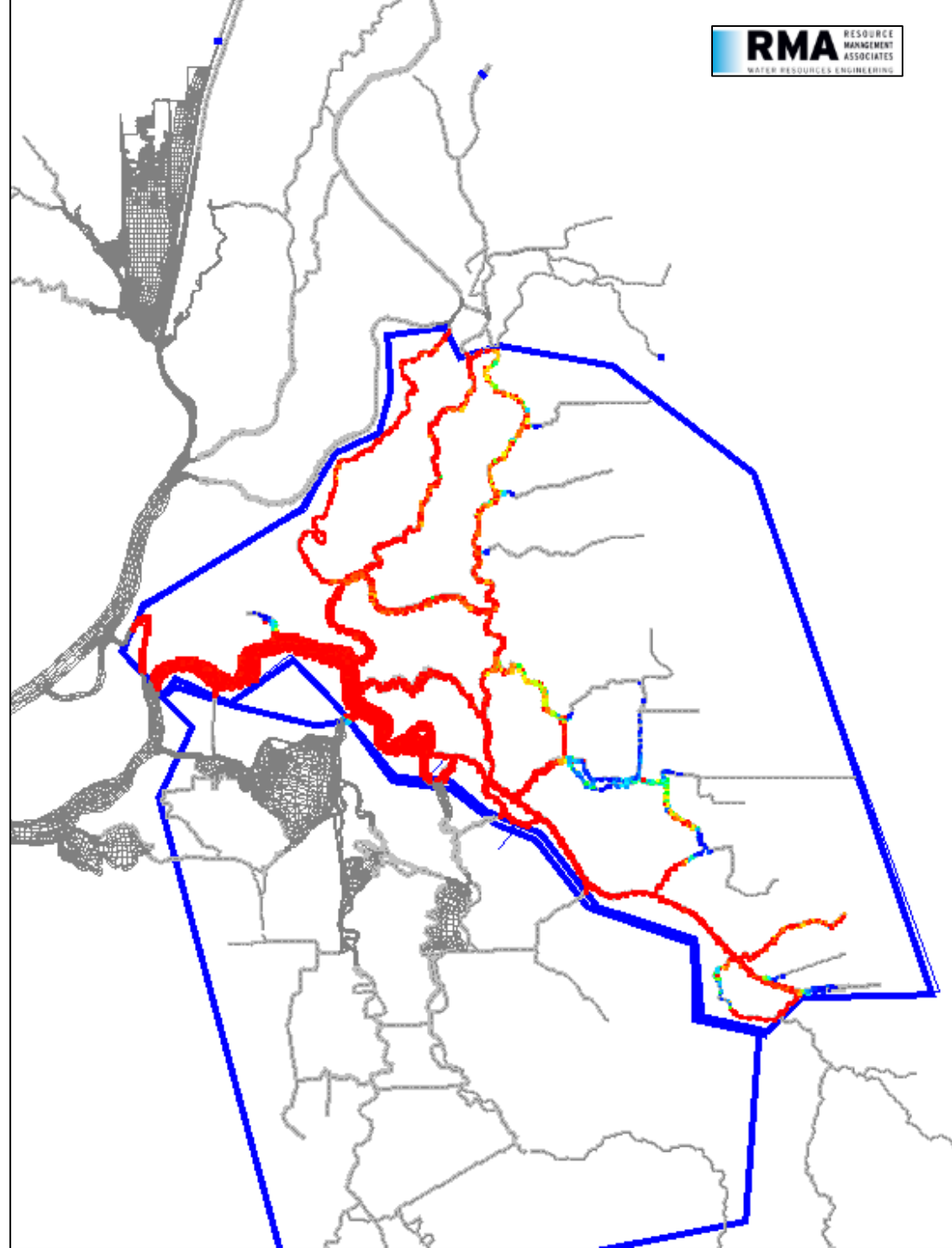
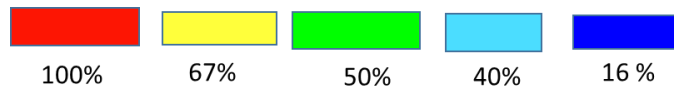
149,504 Particles inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	46%
5 to 10	22%
10 to 15	11%
15 to 20	6%
20 to 25	3%
25-28	1%
>28	12%

	Count	% of Total
Particles Staying	17292	12%
Particles Leaving	132212	88%

Color Scale Shows % of Parcels Exiting Local Cell



Sept 28, 2008 23:45
 Central-Lower Region Fate Map
 149,053 Particles inserted
 (cell size = 100, 150,000 particles)

Exposure Time in Days	% Particles in Range
0 to 5	34%
5 to 10	21%
10 to 15	9%
15 to 20	6%
20 to 25	3%
25 to 28	1%
>28	26%

	Count	% of Total
Particles Staying	38888	26%
Particles Leaving	110165	74%

Color Scale Shows % of Parcels Exiting Local Cell

