

## Appendix 3: Fate and Age Exposure Time Maps for average-flow conditions, September 2010

*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, 2010 00:15 to Sept.28, 2010 23:45
  - RMA Logo should be included on figures
  - NOTE – the velocity file for the Sept. 2010 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, 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 Sept. 28<sup>th</sup>
- 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 Average flow period of analysis

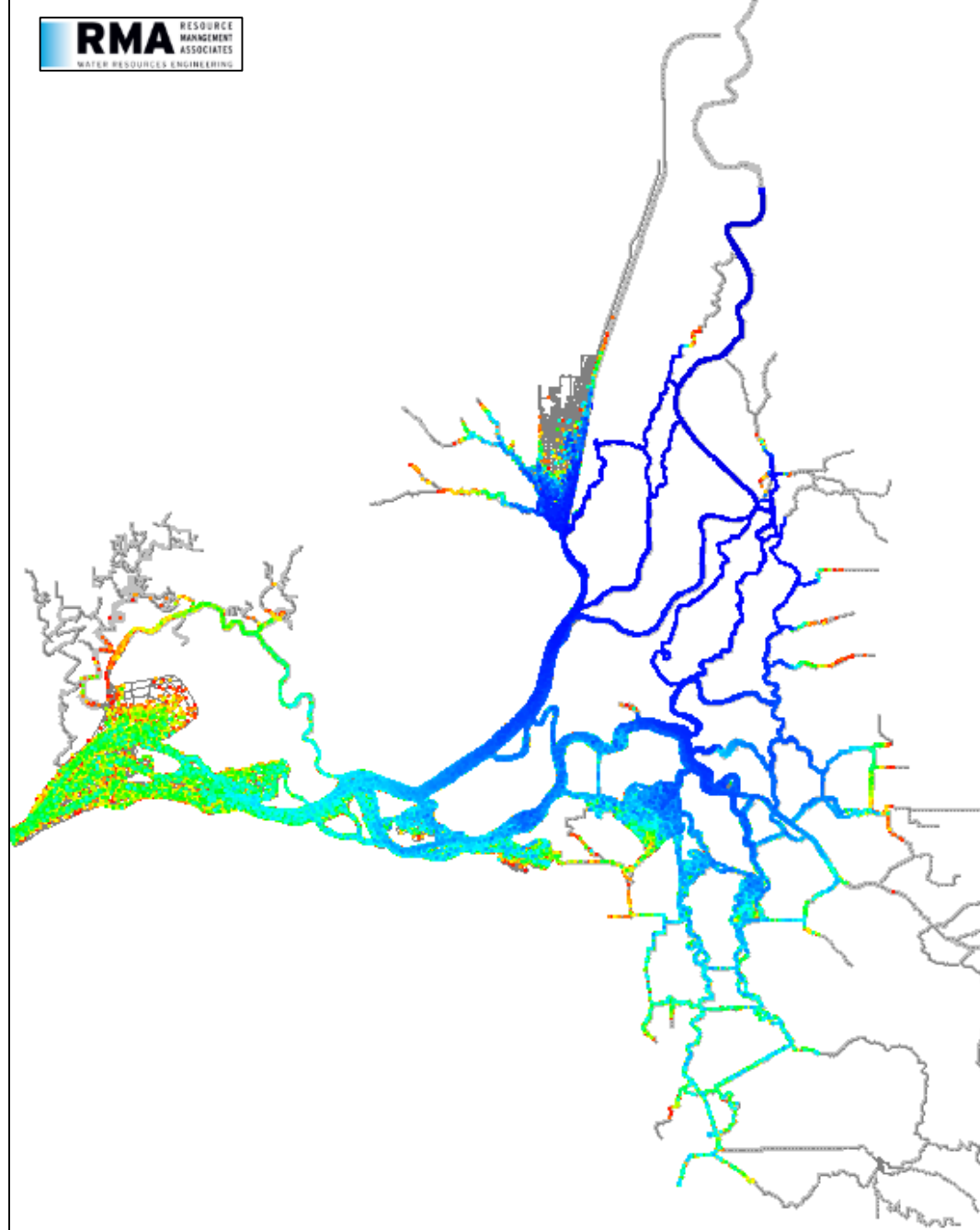
	Flow Type	SJR	SAC R.	CVP+SWP	CALAVERAS	COSUMNES	MOKELUMNE	YOLO+LIS
June, 2011	High	10529	41397	9676	103	947	1786	655
Sept., 2010	Average	1713	16451	10403	21	13	163	158
Sept., 2008	Low	801	10461	4930	32	3	33	110

# 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

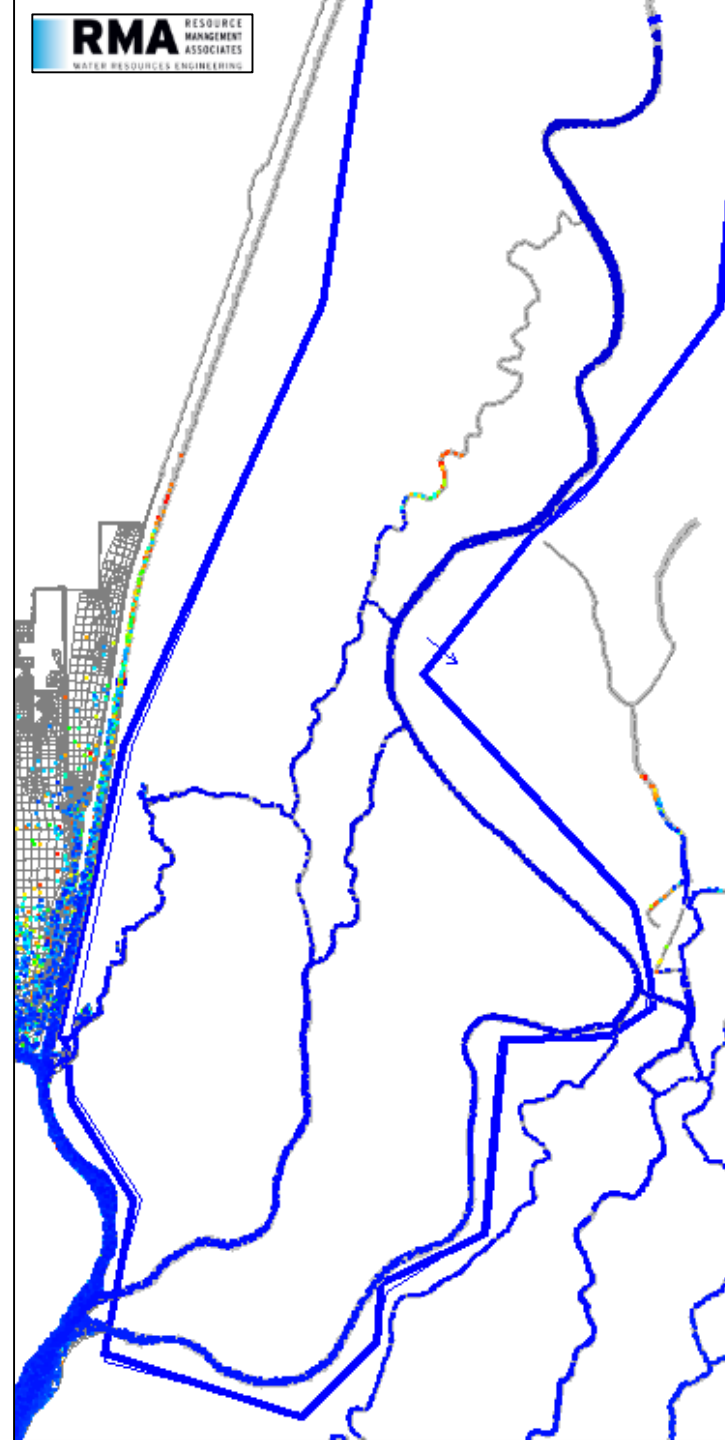
Sept. 28, 2010 23:45  
Sac Source  
134,300 Particles Inserted  
Age in Full Delta

**Color Scale Indicates Approximate Age**



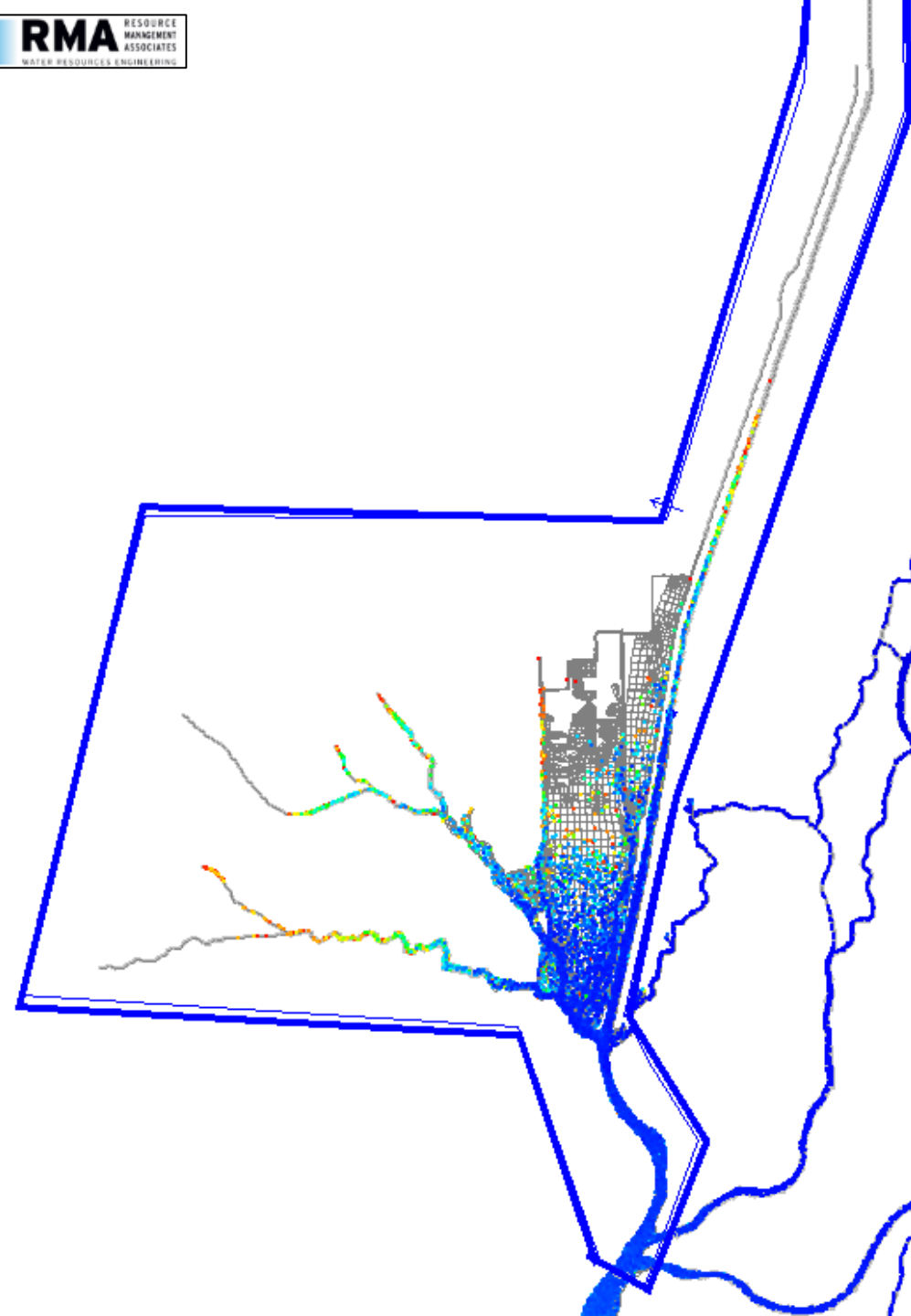
Sept. 28, 2010 23:45  
Sac Source  
134,300 Particles Inserted  
Age in Sacramento Region  
Statistics not calculated

**Color Scale Indicates Approximate Age**



Sept. 28, 2010 18:45  
Sac Source  
134,300 Particles Inserted  
Age in N. Delta Region  
  
View on incoming tide

**Color Scale Indicates Approximate Age**





Sept. 28, 2010 23:45

Sac Source

134,300 Particles Inserted

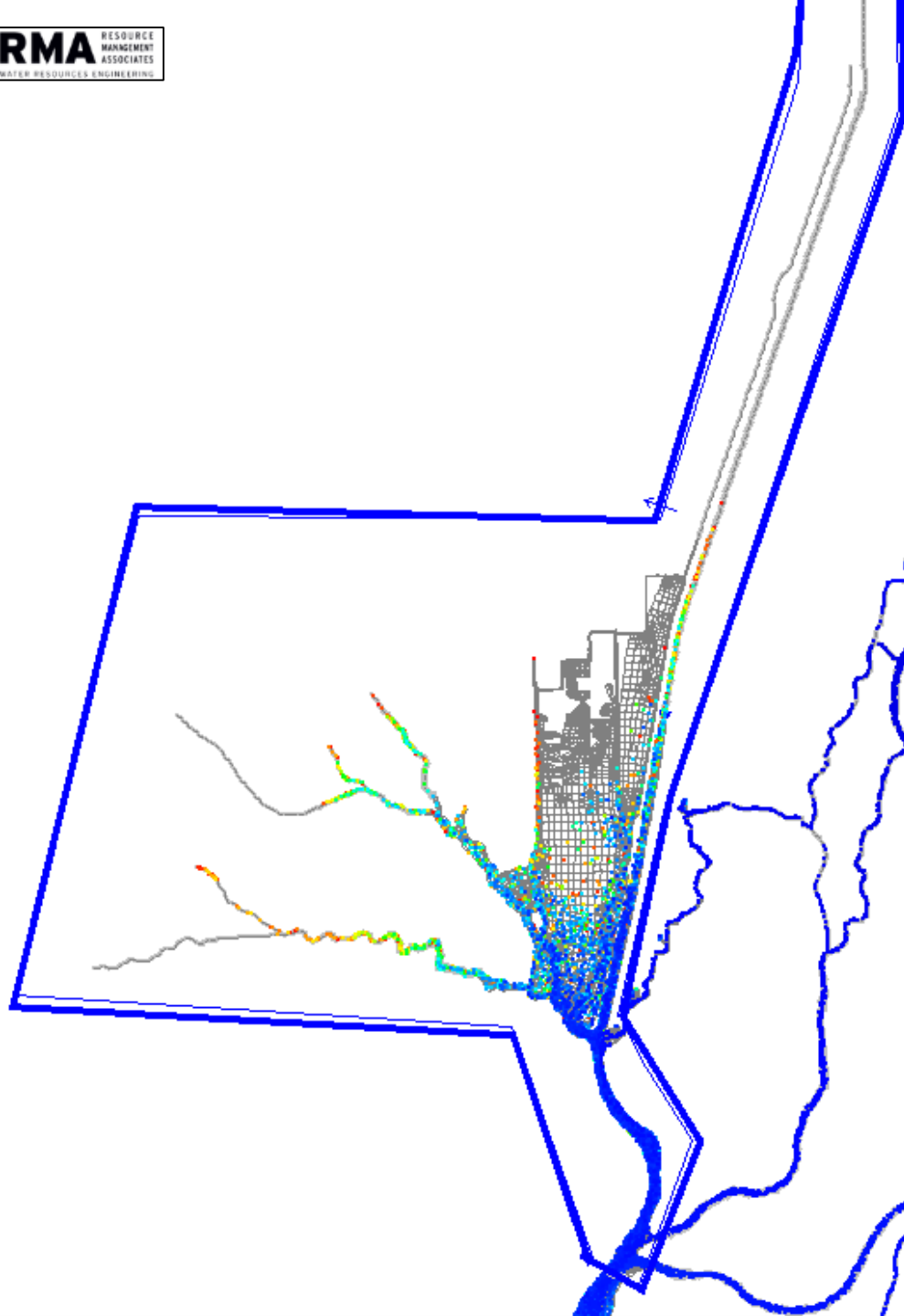
Age in N. Delta Region

View on outgoing tide

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	79%	99%
5 to 10	18%	1%
10 to 15	2%	0%
15 to 20	1%	0%
20 to 25	0%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	56744	100%	42%
Particles Staying	50211	88%	37%
Particles Leaving	6533	12%	5%

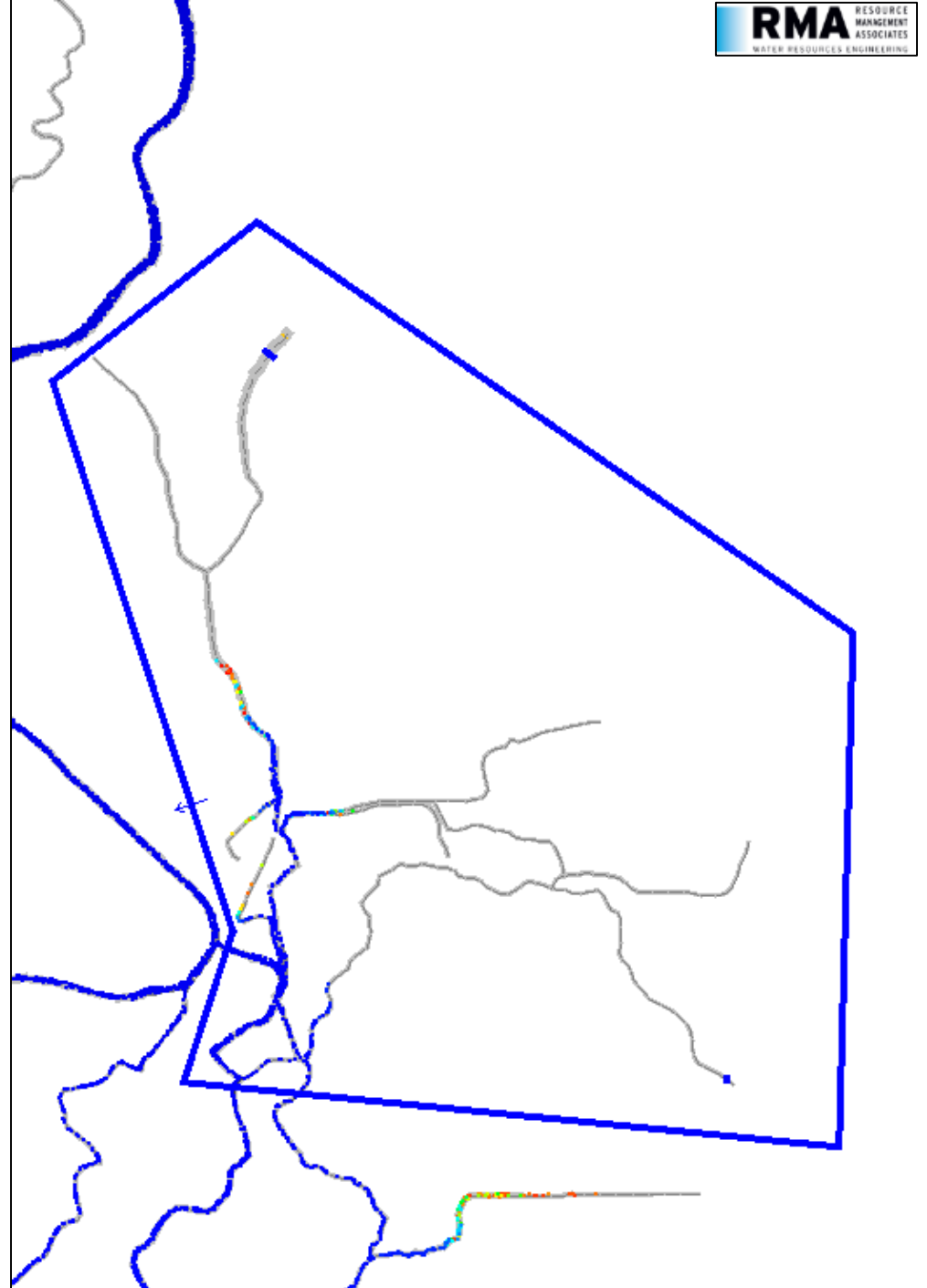
Color Scale Indicates Approximate Age



Sept. 28, 2010 23:45  
Sac Source  
134,300 Particles Inserted  
Age in Eastside Region

Statistics not calculated

**Color Scale Indicates Approximate Age**



Sept. 28, 2010 23:45

Sac Source

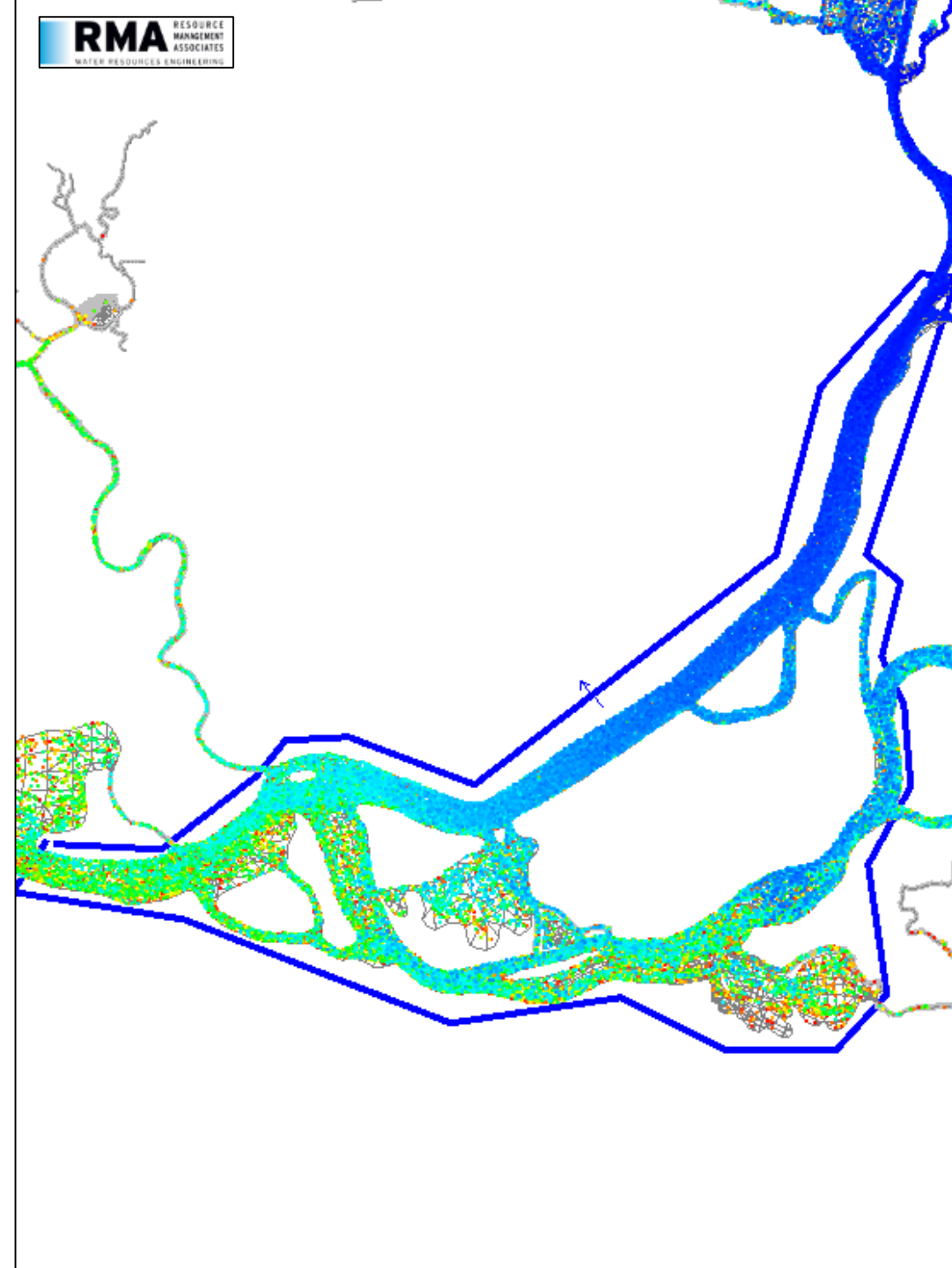
134,300 Particles Inserted

Age in Confluence Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	32%	50%
5 to 10	15%	24%
10 to 15	25%	19%
15 to 20	17%	6%
20 to 25	9%	1%
25 to 28	3%	0%

	Count	Regional %	% of Total
Particles Entering	67061	100%	50%
Particles Staying	37319	56%	28%
Particles Leaving	29742	44%	22%

Color Scale Indicates Approximate Age

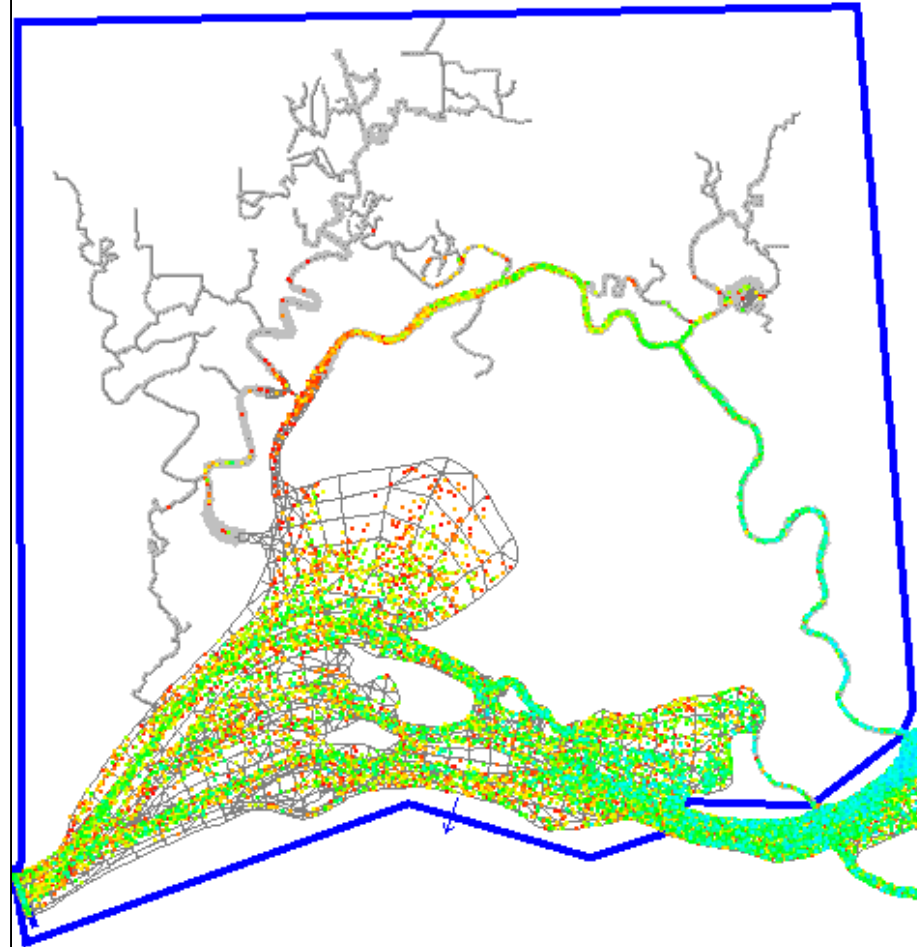


Sept. 28, 2010 23:45  
Sac Source  
134,300 Particles Inserted  
Age in Suisun Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	92%
5 to 10	5%	7%
10 to 15	43%	1%
15 to 20	31%	0%
20 to 25	17%	0%
25 to 28	4%	0%

	Count	Regional %	% of Total
Particles Entering	21089	100%	16%
Particles Staying	15772	75%	12%
Particles Leaving	5317	25%	4%

Color Scale Indicates Approximate Age



Sept. 28, 2010 23:45

Sac Source

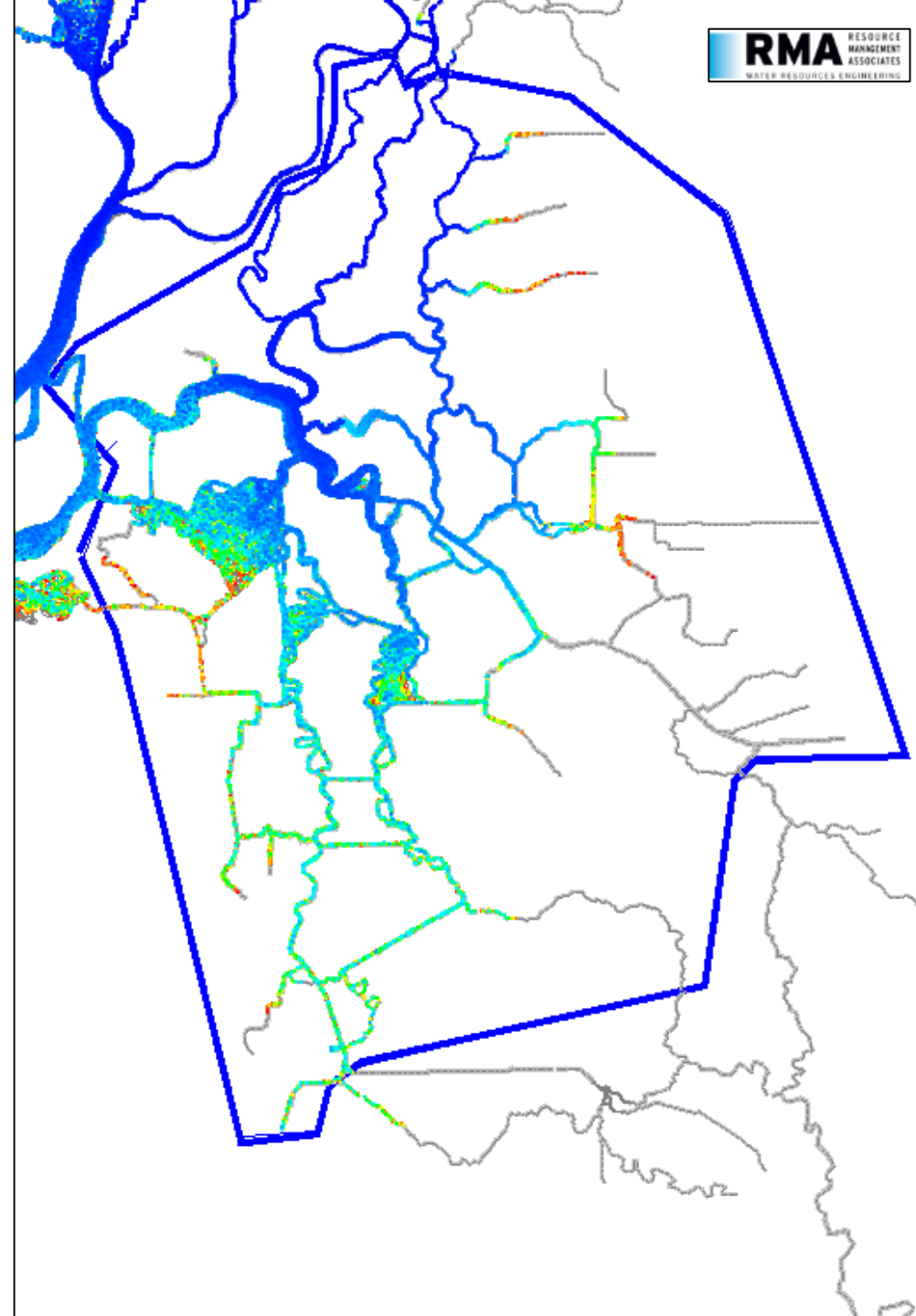
134,300 Particles Inserted

Age in Central Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	18%	30%
5 to 10	5%	0%
10 to 15	4%	0%
15 to 20	2%	0%
20 to 25	1%	0%
25 to 28	70%	70%

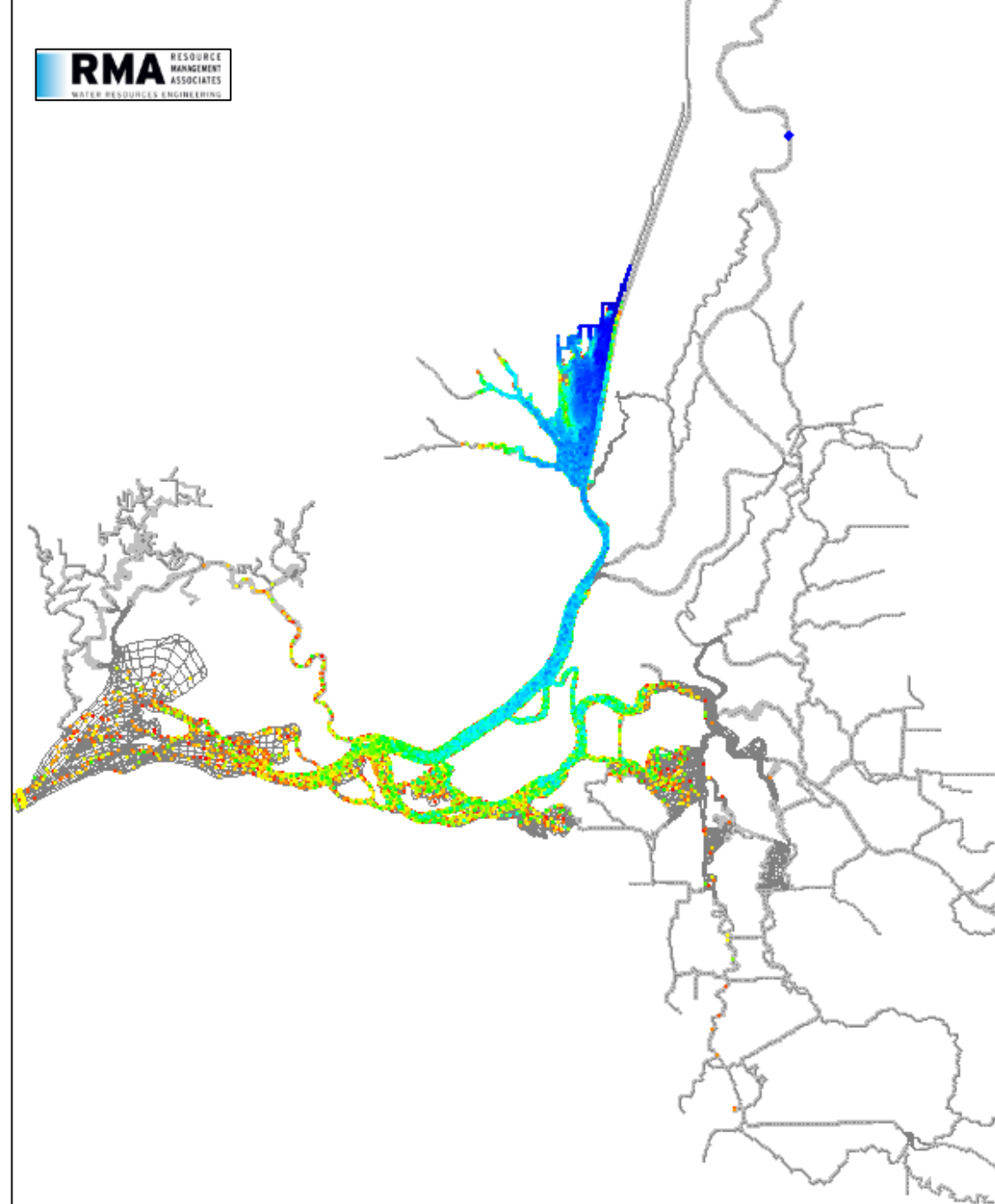
	Count	Regional %	% of Total
Particles Entering	68990	100%	51%
Particles Staying	54907	80%	41%
Particles Leaving	14083	20%	10%

Color Scale Indicates Approximate Age



Sept. 28, 2010 23:45  
Yolo Source  
134,300 Particles Inserted  
Age in Full Delta

**Color Scale Indicates Approximate Age**

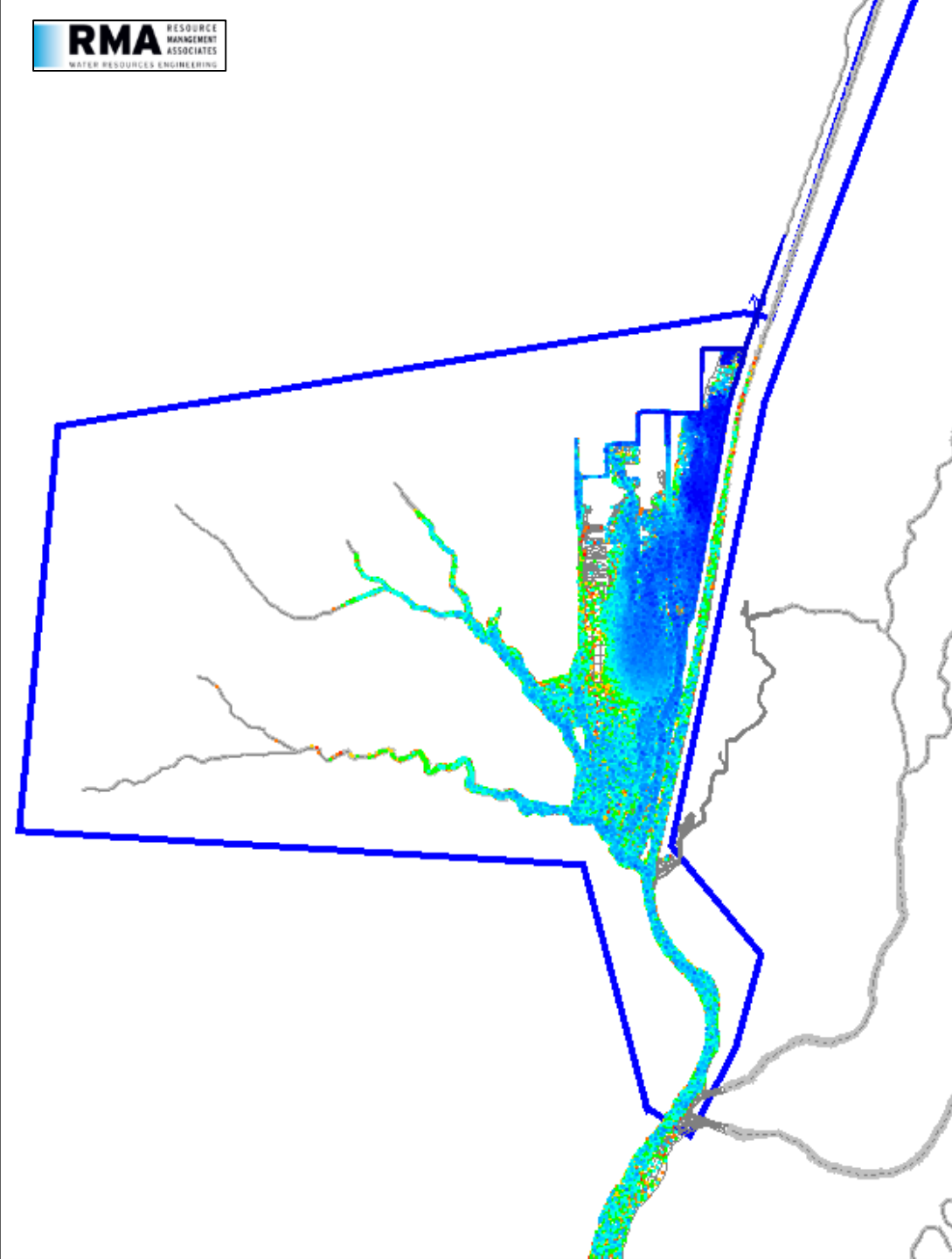


Sept. 28, 2010 23:45  
Yolo Source  
134,300 Particles Inserted  
Age in N. Delta Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	74%	93%
5 to 10	13%	7%
10 to 15	5%	0%
15 to 20	4%	0%
20 to 25	3%	0%
25 to 28	1%	0%

	Count	Regional %	% of Total
Particles Entering	133005	100%	99%
Particles Staying	17717	13%	13%
Particles Leaving	115288	87%	86%

Color Scale Indicates Approximate Age



Sept. 28, 2010 23:45

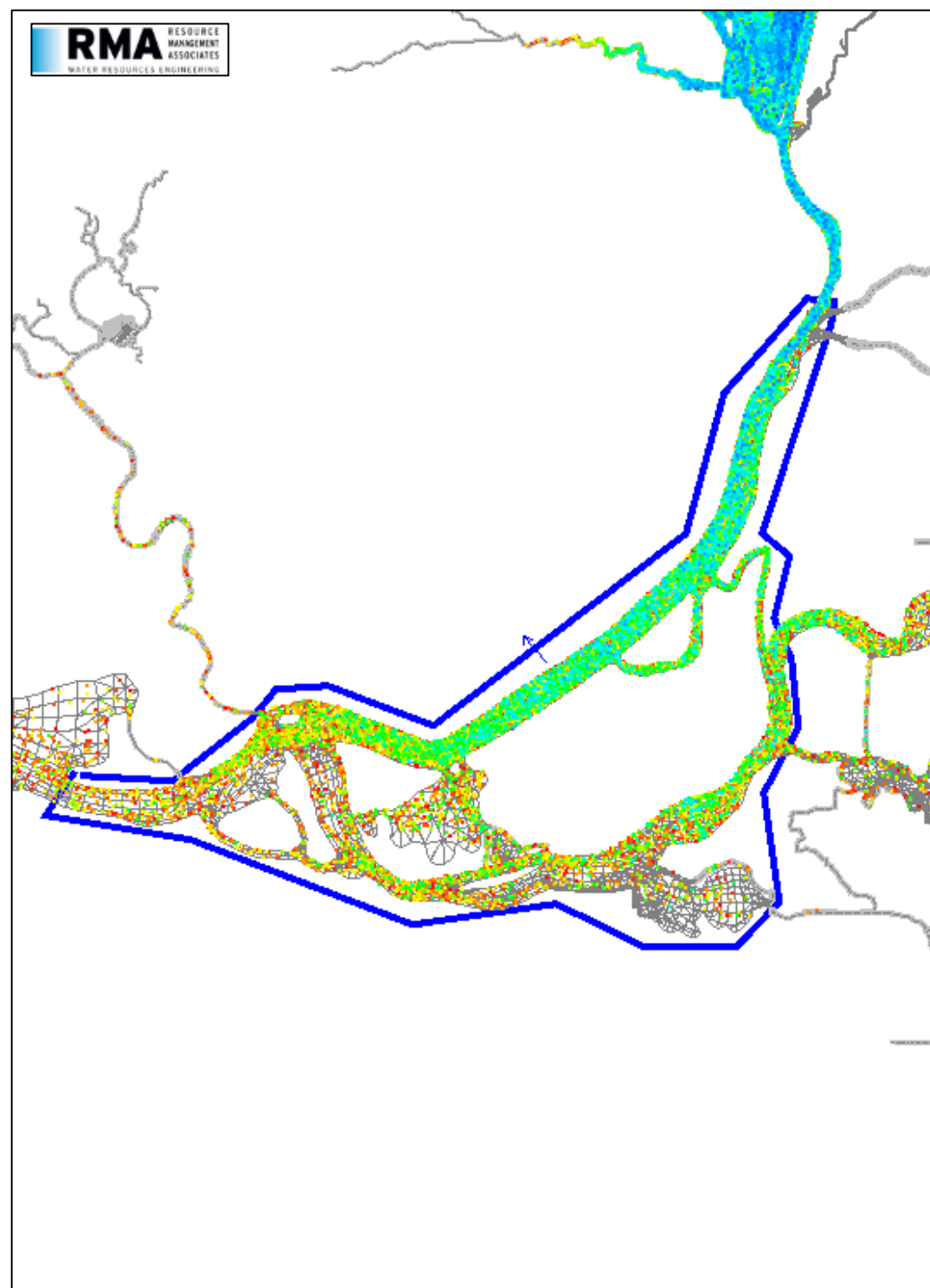
Yolo Source

134,300 Particles Inserted  
Age in Confluence Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	86%
5 to 10	12%	12%
10 to 15	26%	2%
15 to 20	31%	0%
20 to 25	24%	0%
25 to 28	7%	0%

	Count	Regional %	% of Total
Particles Entering	19982	100%	15%
Particles Staying	15190	76%	11%
Particles Leaving	4792	24%	4%

Color Scale Indicates Approximate Age



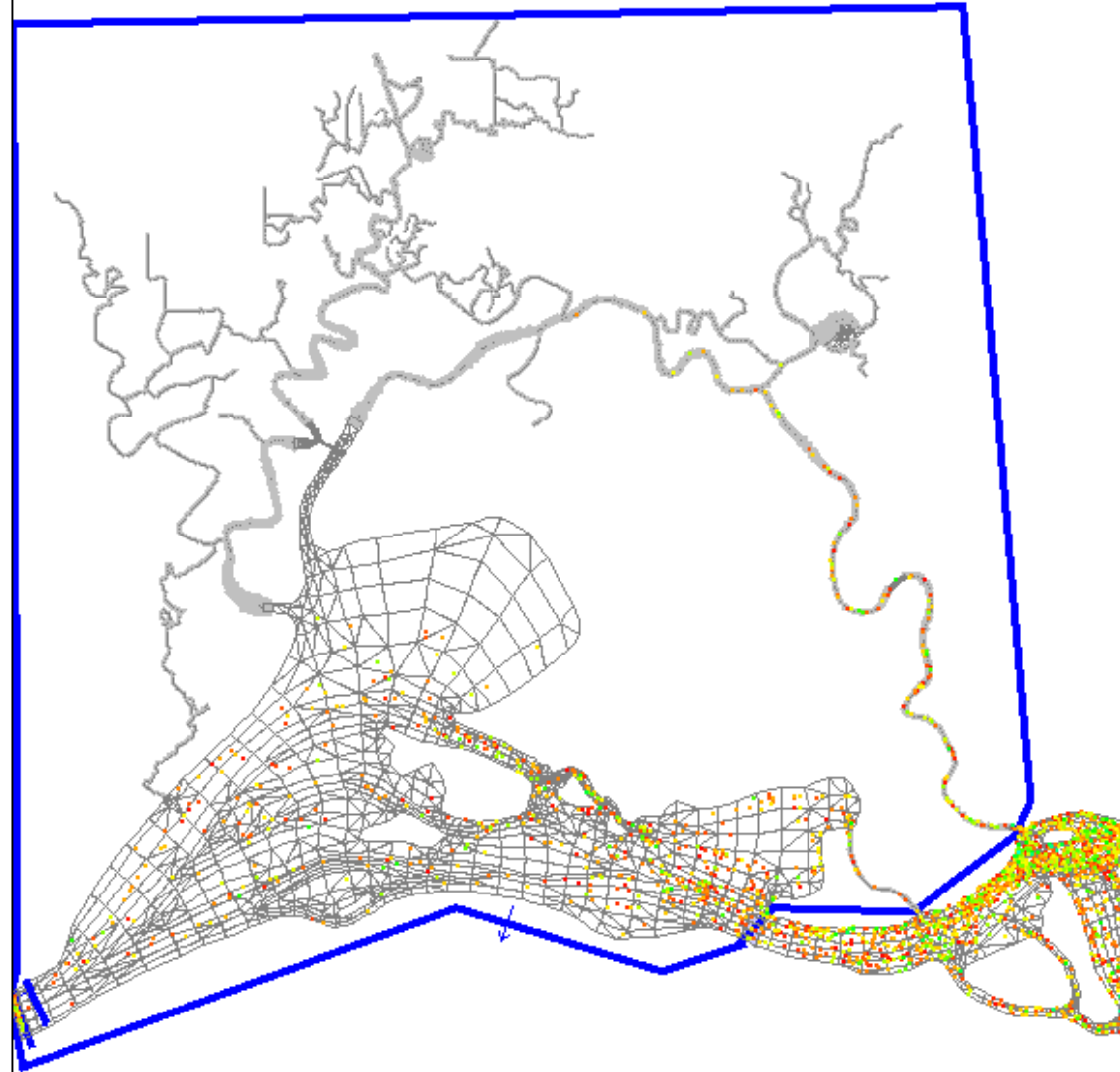


Sept. 28, 2010 23:45  
Yolo Source  
134,300 Particles Inserted  
Age in Suisun Region

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	6%	8%
15 to 20	37%	40%
20 to 25	42%	40%
25 to 28	15%	12%

	Count	Regional %	% of Total
Particles Entering	1205	100%	1%
Particles Staying	464	39%	0%
Particles Leaving	741	61%	1%

Color Scale Indicates Approximate Age

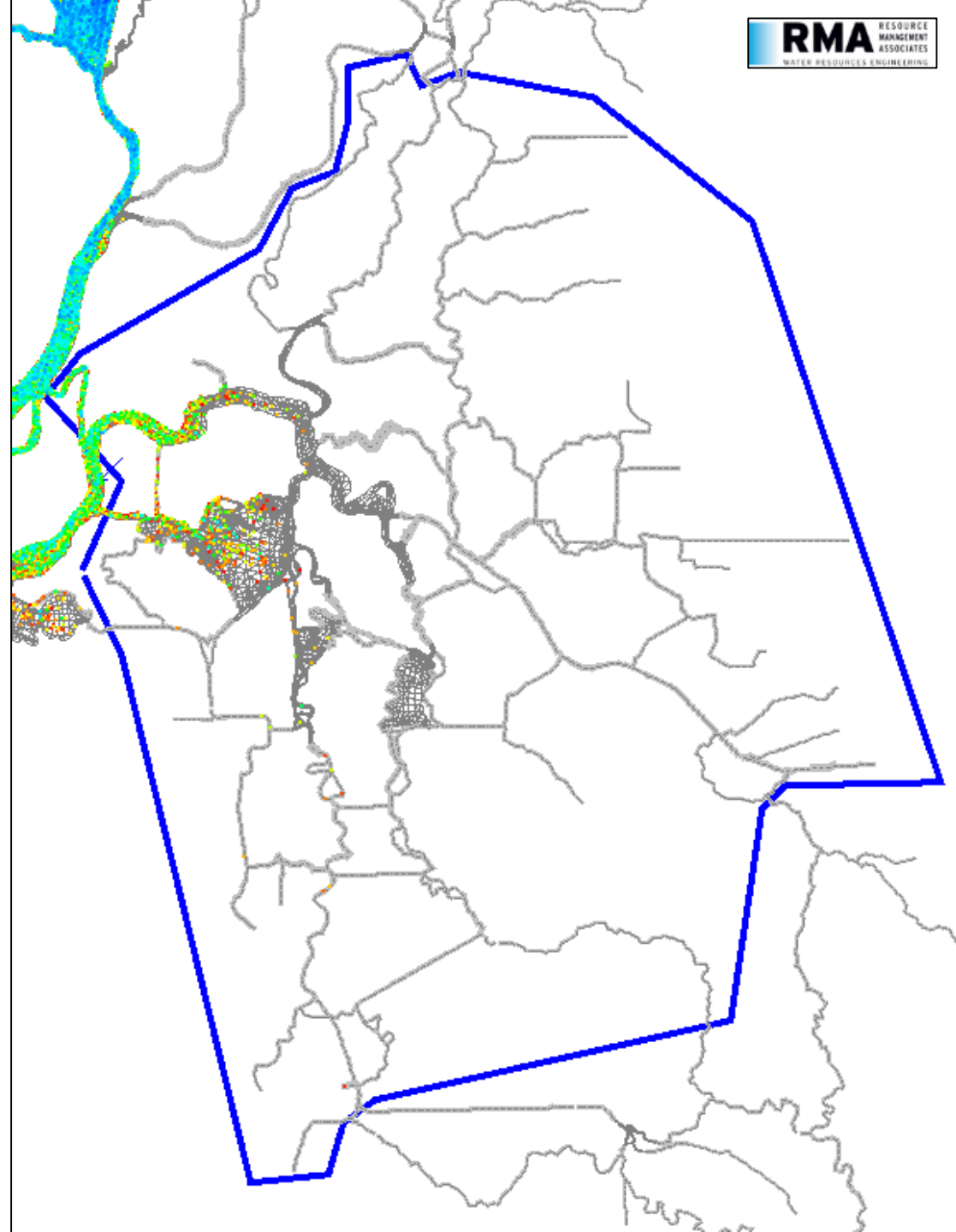


Sept. 28, 2010 23:45  
Yolo Source  
134,300 Particles Inserted  
Age in Central Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	0%	0%
5 to 10	2%	4%
10 to 15	19%	24%
15 to 20	33%	33%
20 to 25	32%	31%
25 to 28	14%	8%

	Count	Regional %	% of Total
Particles Entering	4258	100%	3%
Particles Staying	2749	65%	2%
Particles Leaving	1509	35%	1%

Color Scale Indicates Approximate Age



Sept. 28, 2010 22:15

MTZ Source

134,300 Particles Inserted

Age in Suisun Region

View on incoming tide

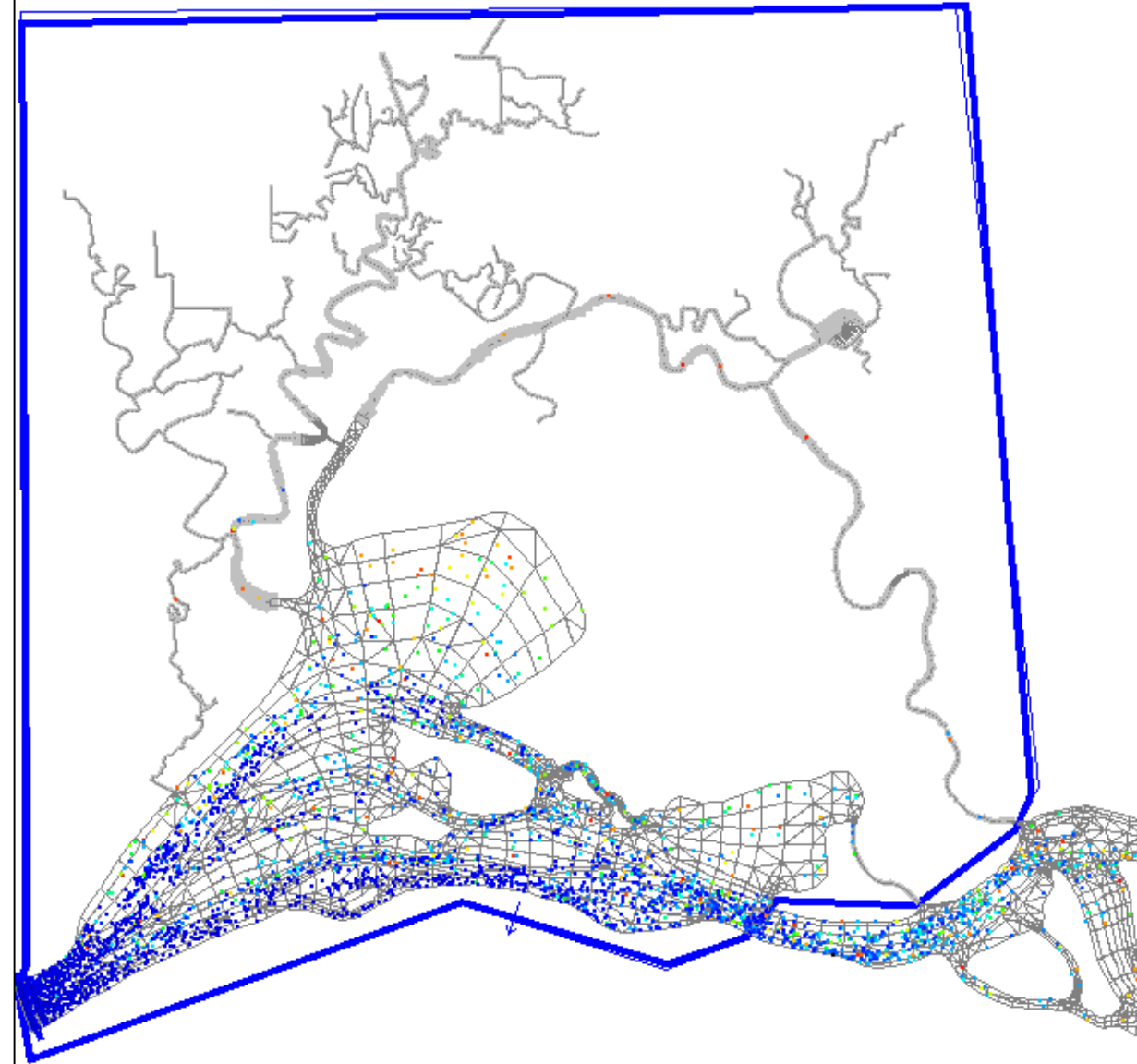
Note – Most particles 'killed' at MTZ

Statistics calculated for simulation end, 23:45

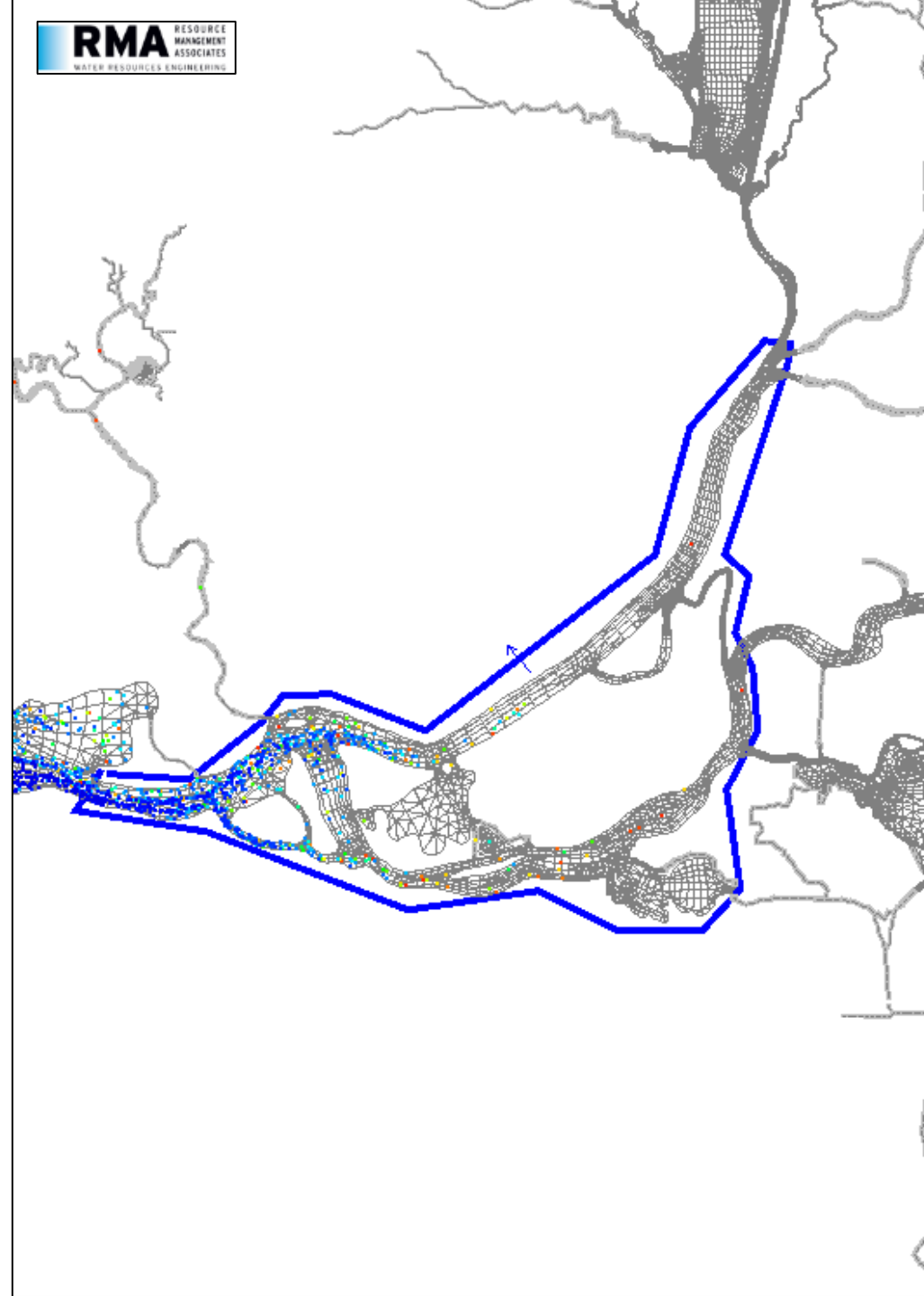
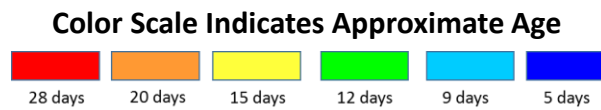
Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	75%	96%
5 to 10	16%	2%
10 to 15	5%	1%
15 to 20	2%	1%
20 to 25	1%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	9095	100%	7%
Particles Staying	5172	57%	4%
Particles Leaving	3923	43%	3%

Color Scale Indicates Approximate Age



Sept. 28, 2010 18:45  
MTZ Source  
134,300  
Particles Inserted  
Age in Confluence Region  
View on incoming tide

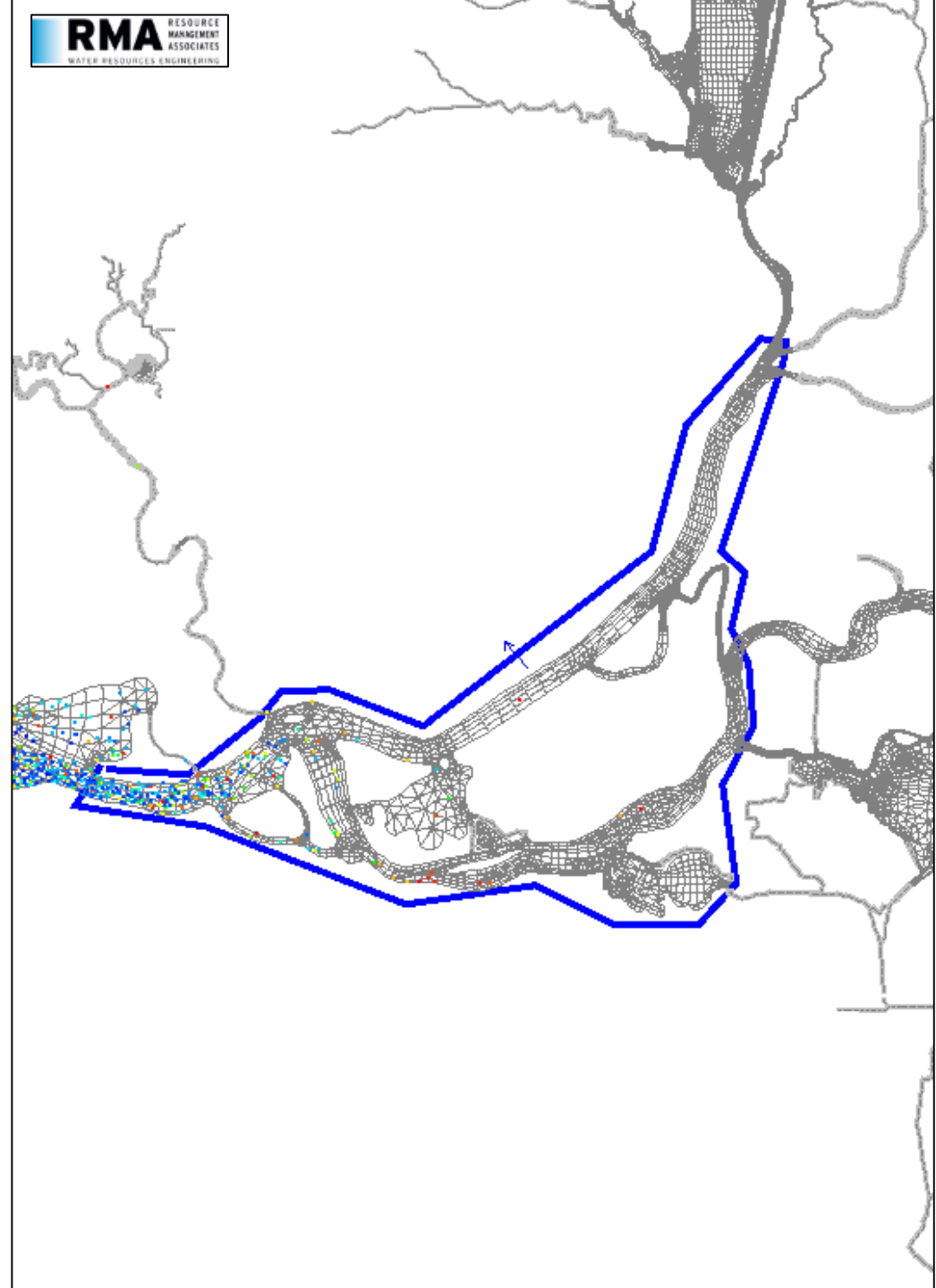


Sept. 28, 2010 23:45  
MTZ Source  
134,300  
Particles Inserted  
Age in Confluence Region  
View on outgoing tide

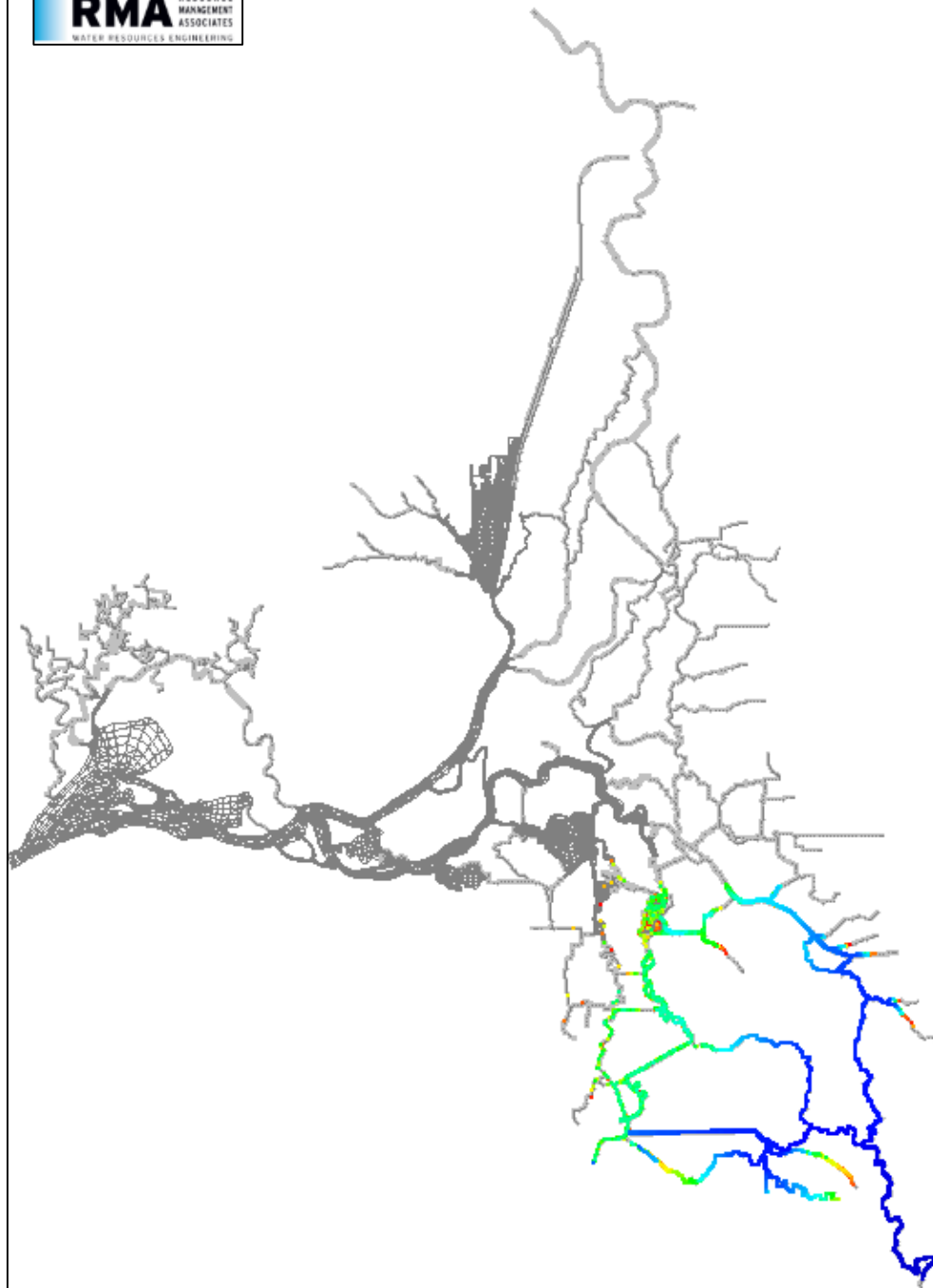
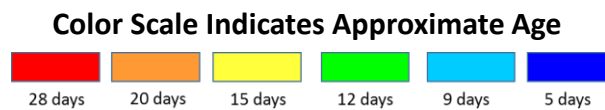
Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	53%	92%
5 to 10	30%	5%
10 to 15	11%	2%
15 to 20	4%	1%
20 to 25	1%	0%
25 to 28	1%	0%

	Count	Regional %	% of Total
Particles Entering	4105	100%	3%
Particles Staying	252	6%	0%
Particles Leaving	3853	94%	3%

Color Scale Indicates Approximate Age



Sept. 28, 2010 23:45  
San Joaquin Source  
134,300 Particles Inserted  
Age In Full Delta

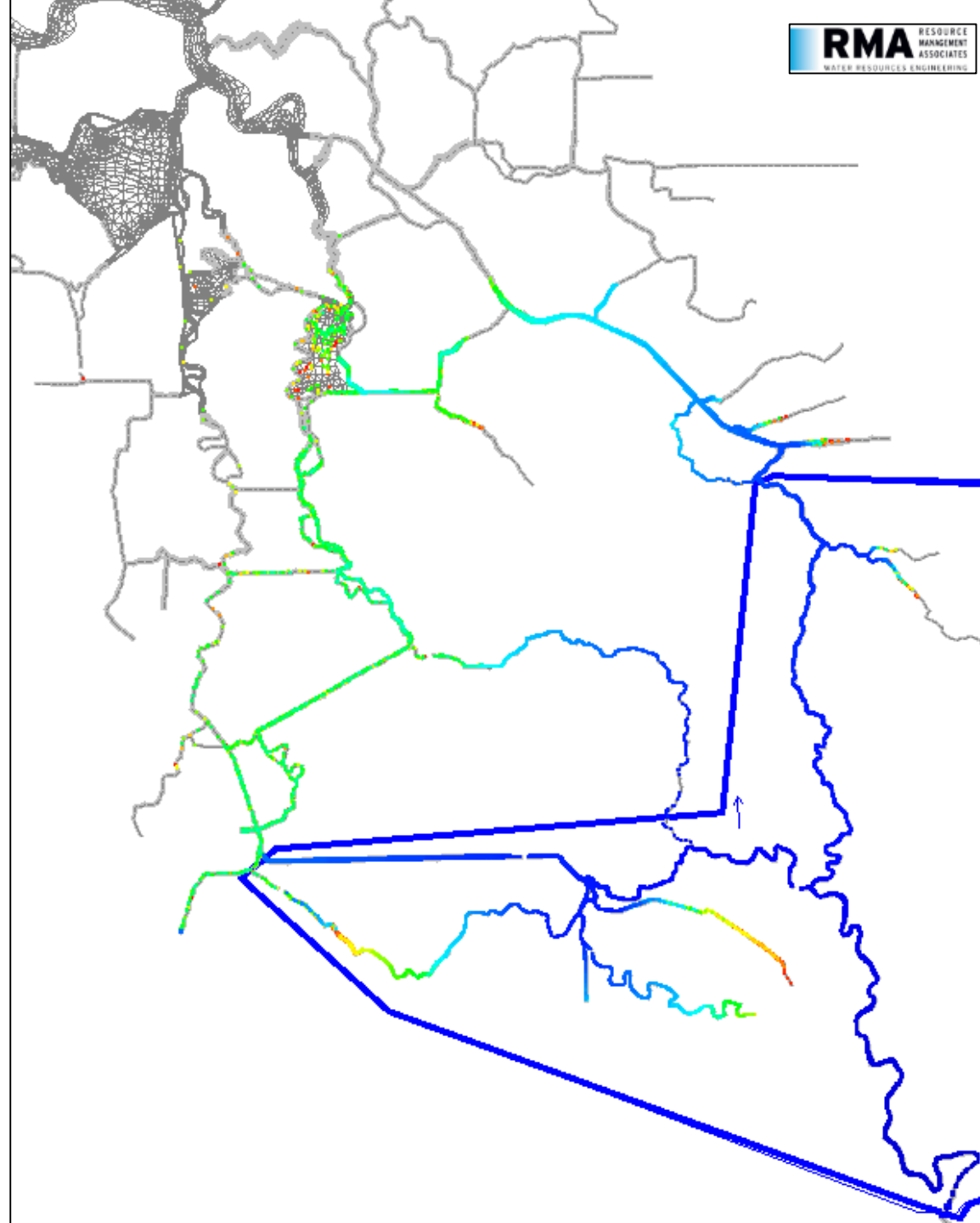
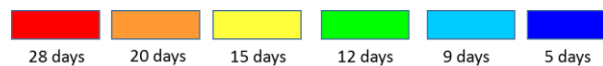


Sept. 28, 2010 23:45  
San Joaquin Source  
134,300 Particles Inserted  
Age In S. Delta Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	40%	99%
5 to 10	37%	1%
10 to 15	23%	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	84149	63%	63%
Particles Leaving	50151	37%	37%

Color Scale Indicates Approximate Age





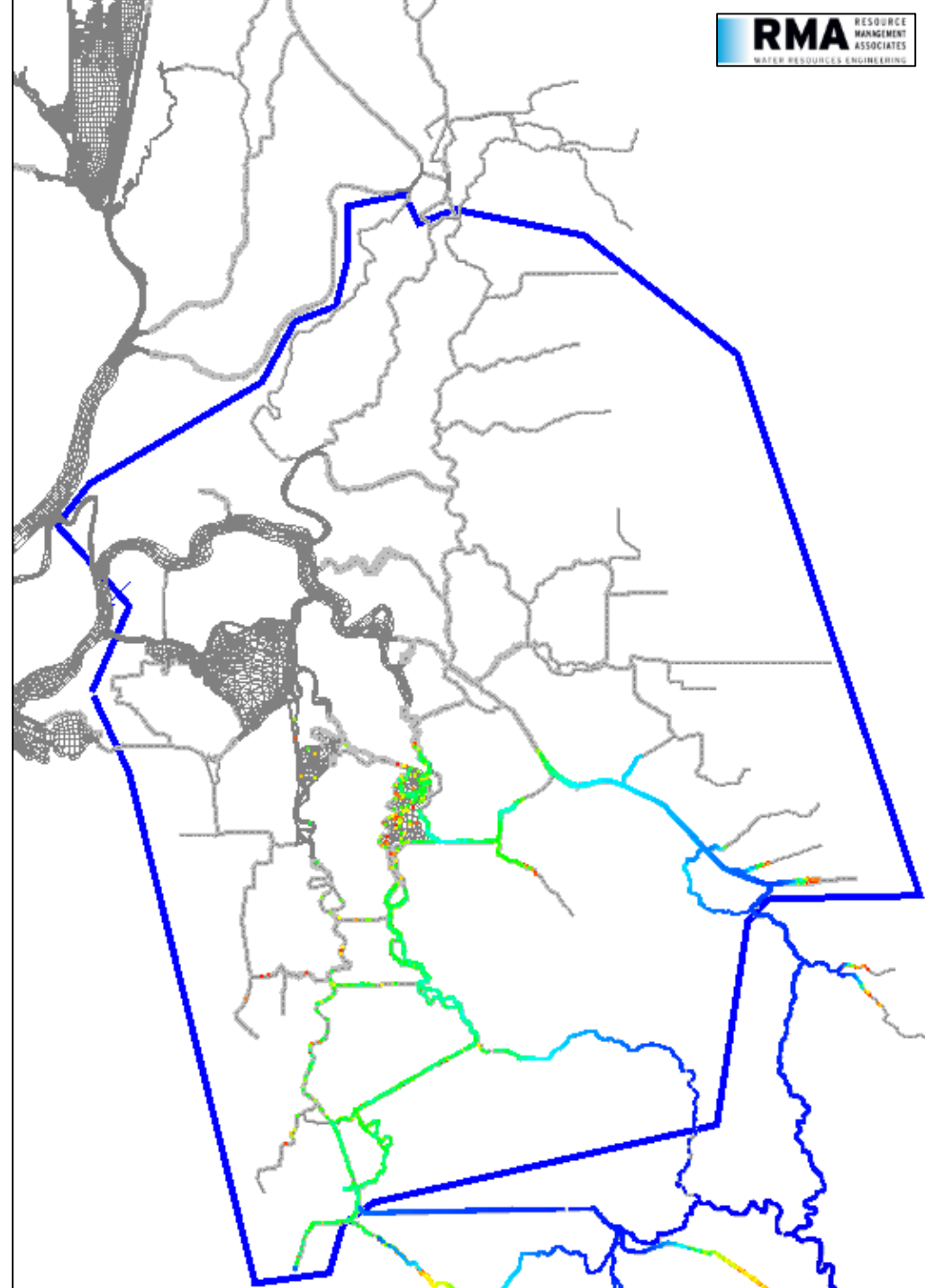
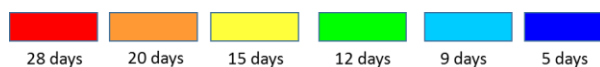
Sept. 28, 2010 23:45  
 San Joaquin Source  
 134,300 Particles Inserted  
 Age in Central Region

Note: Particles can be exported at SWP, CVP

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	69%	87%
5 to 10	17%	13%
10 to 15	4%	0%
15 to 20	7%	0%
20 to 25	2%	0%
25 to 28	0%	0%

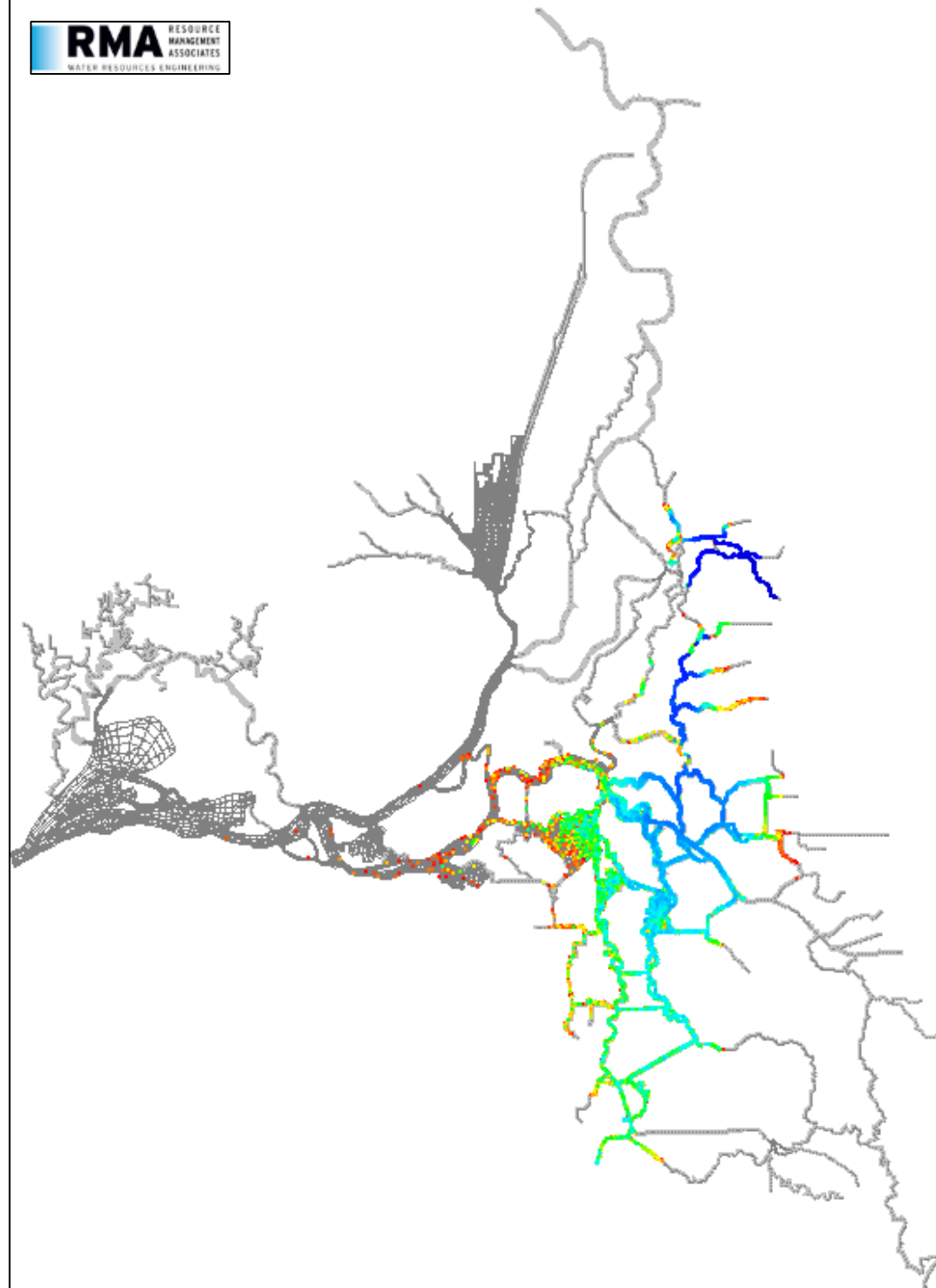
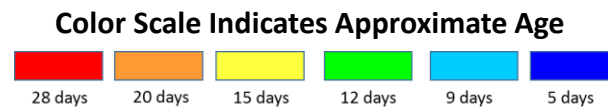
	Count	Regional %	% of Total
Particles Entering	103261	100%	77%
Particles Staying	2696	3%	2%
Particles Leaving	100565	97%	75%

Color Scale Indicates Approximate Age





Sept. 28, 2010 23:45  
Mokelumne Source  
134,300 Particles Inserted  
Age in Full Delta

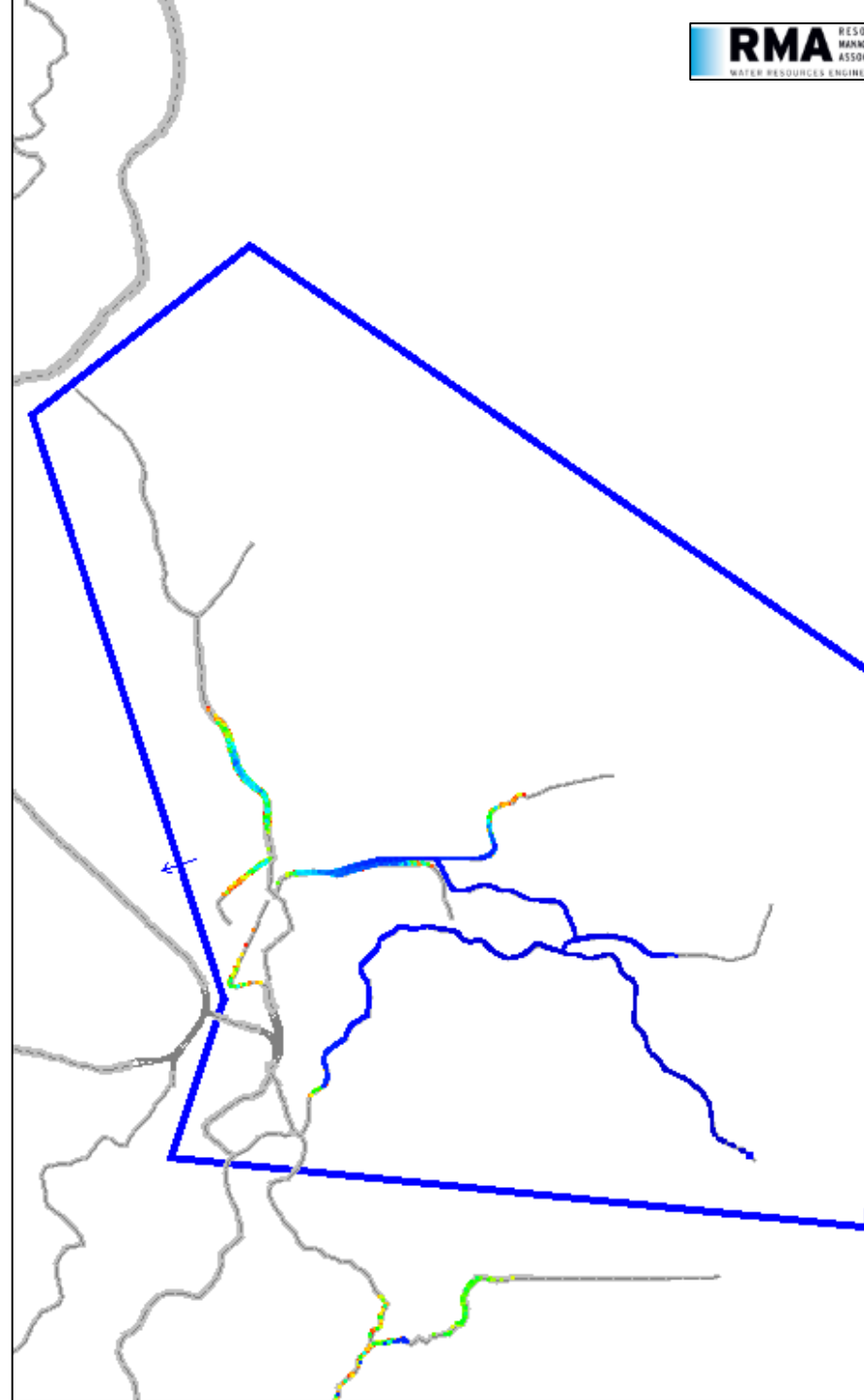


Sept. 28, 2010 23:45  
Mokelumne Source  
134,300 Particles Inserted  
Age in Eastside Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	96%	100%
5 to 10	2%	0%
10 to 15	1%	0%
15 to 20	1%	0%
20 to 25	1%	0%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	134300	100%	100%
Particles Staying	25749	19%	19%
Particles Leaving	108551	81%	81%

Color Scale Indicates Approximate Age

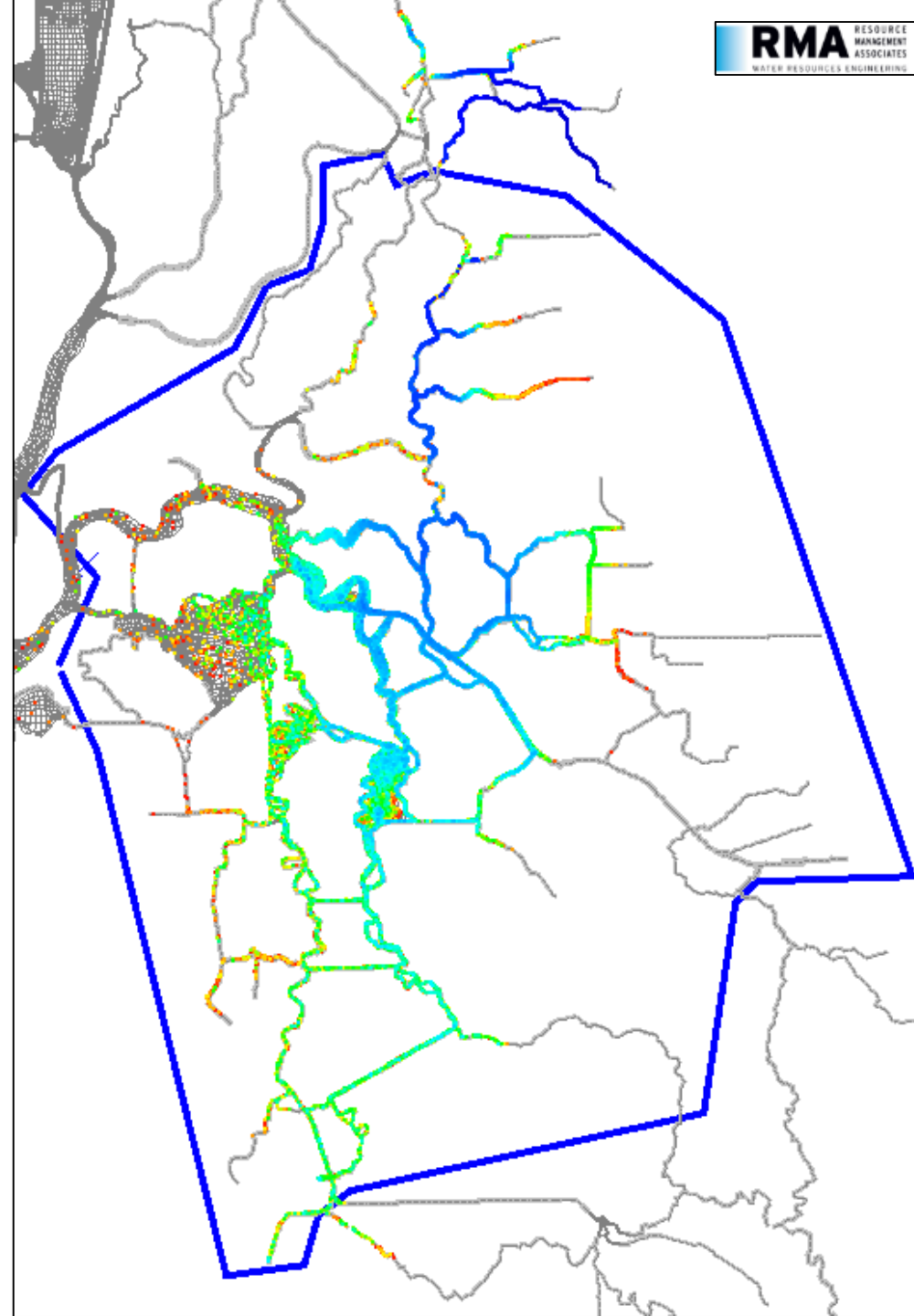


Sept. 28, 2010 23:45  
Mokelumne Source  
134,300 Particles Inserted  
Age in Central Region

Exposure Time in Days	% Particles in Age Range	% Particles in Exp Time
0 to 5	85%	96%
5 to 10	2%	2%
10 to 15	2%	0%
15 to 20	7%	1%
20 to 25	4%	1%
25 to 28	0%	0%

	Count	Regional %	% of Total
Particles Entering	109172	100%	81%
Particles Staying	108222	99%	81%
Particles Leaving	950	1%	1%

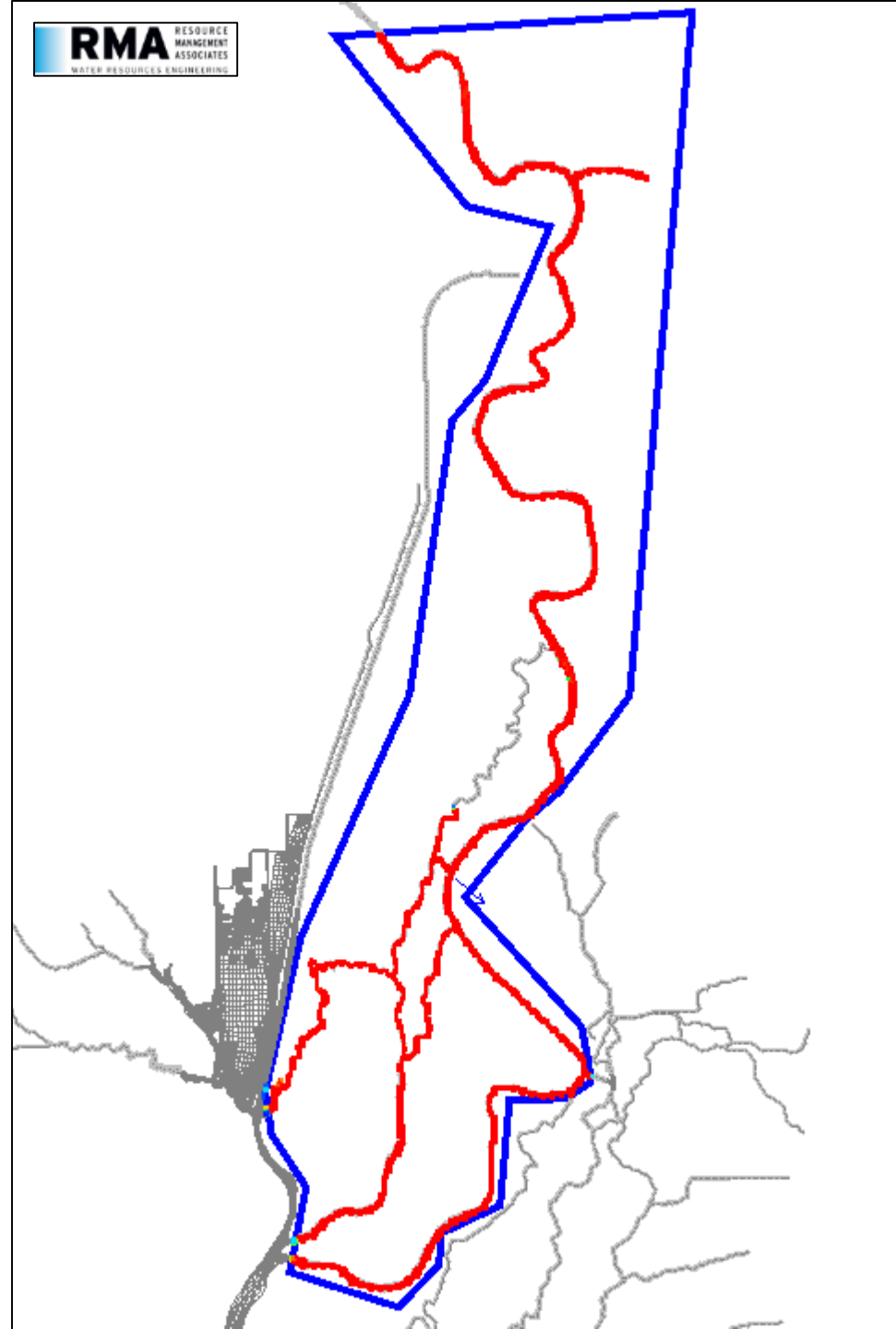
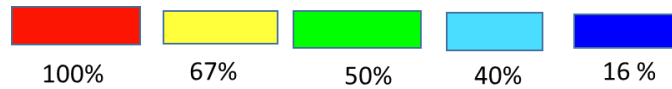
Color Scale Indicates Approximate Age



Sept. 28, 2010 23:45  
Sacramento Region Fate Map  
99,817 Particles Inserted

Statistics not computed  
(cell size = 100, 100,000 particles)

**Color Scale Shows % of Parcels Exiting Region**

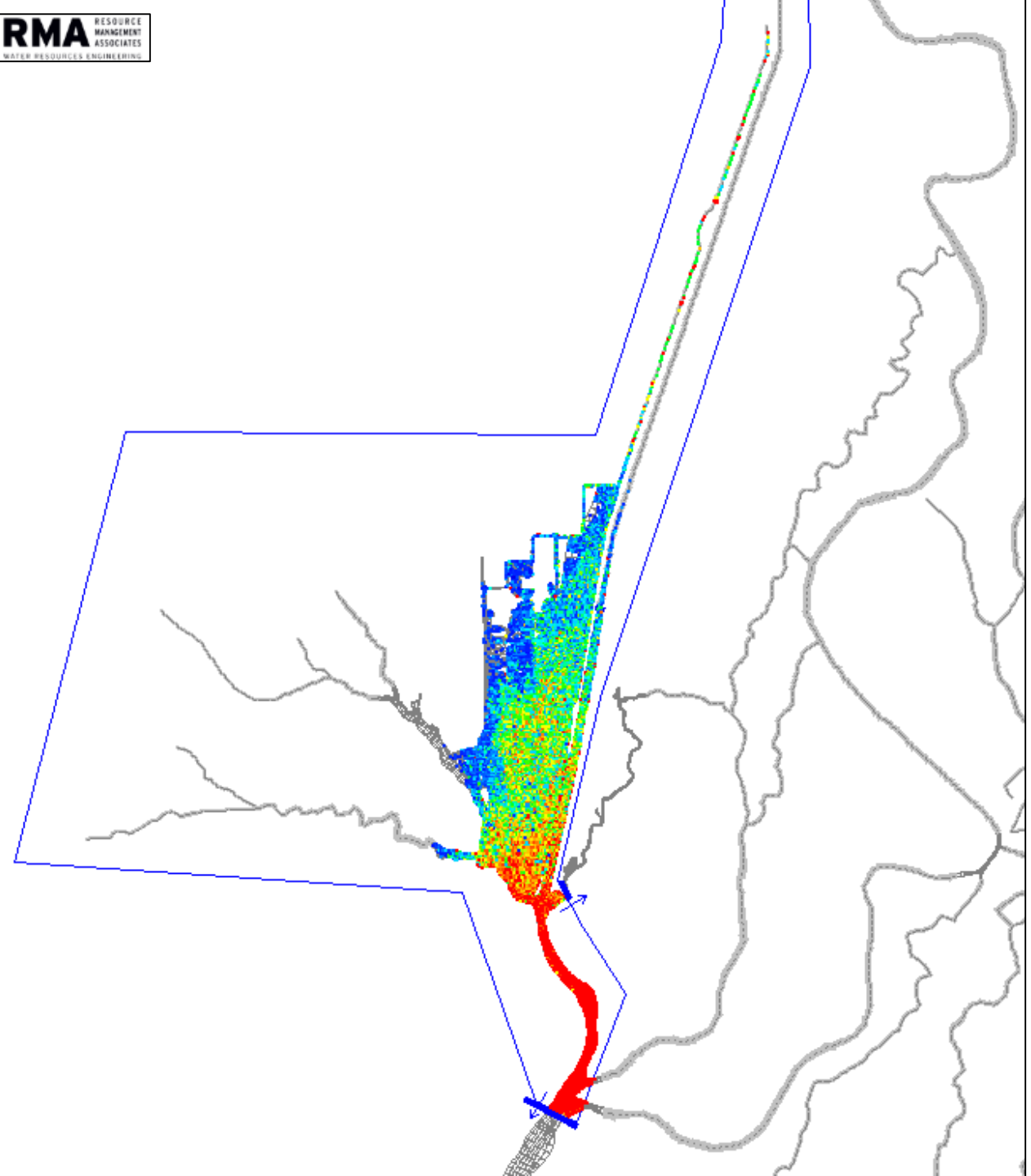
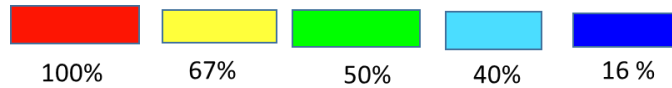


Sept. 28, 2010 23:45  
N. Delta Region Fate Map  
148,440 Particles Inserted  
(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	0%
5 to 10	4%
10 to 15	4%
15 to 20	2%
20 to 25	1%
25 to 28	0%
>28	89%

	Count	% of Total
Particles Staying	131574	89%
Particles Leaving	16866	11%

Color Scale Shows % of Parcels Exiting Region



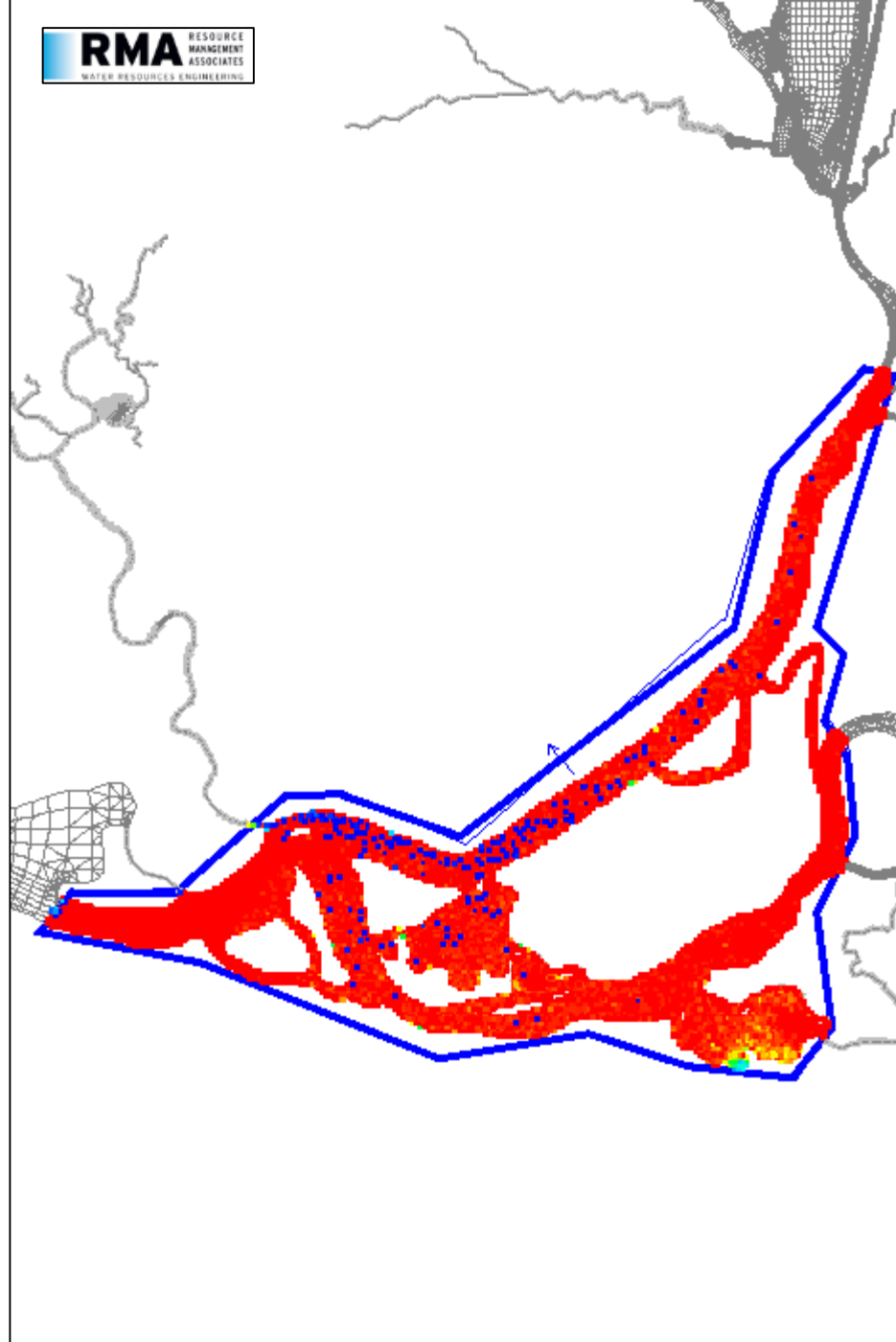
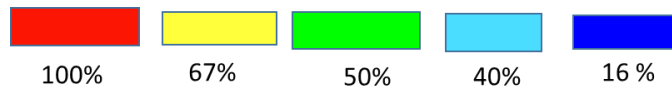
Sept. 28, 2010 23:45  
Confluence Region Fate Map  
149,237 Particles Inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	60%
5 to 10	21%
10 to 15	10%
15 to 20	4%
20 to 25	2%
25 to 28	1%
>28	3%

	Count	% of Total
Particles Staying	4548	3%
Particles Leaving	144689	97%

Color Scale Shows % of Parcels Exiting Region



Sept. 28, 2010 23:45

Suisun Region Fate Map

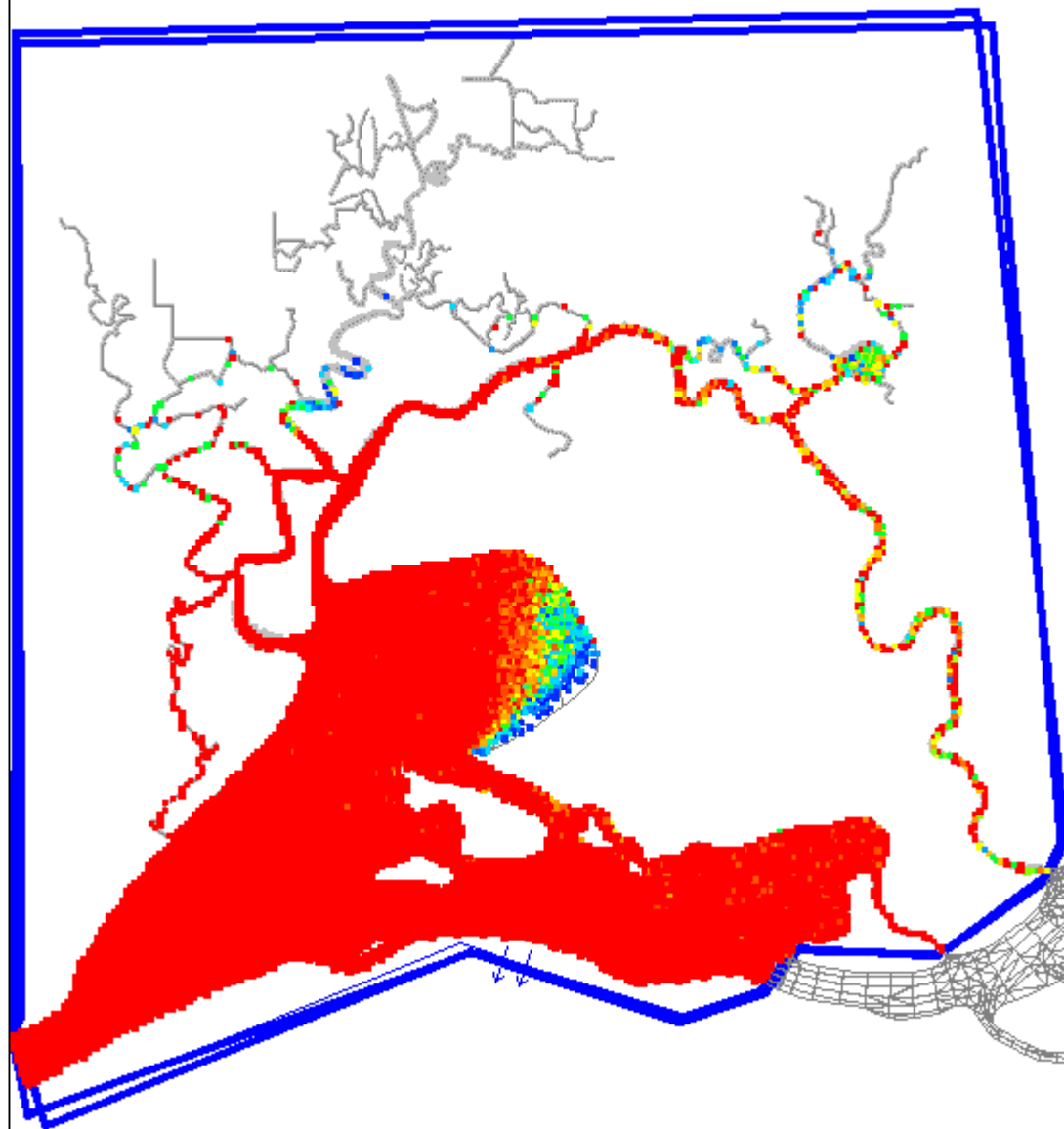
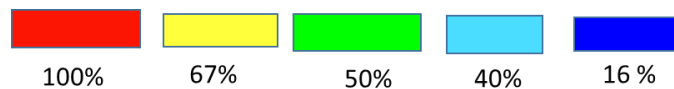
99,437 Particles Inserted

(cell size = 100, 100,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	67%
5 to 10	12%
10 to 15	6%
15 to 20	3%
20 to 25	3%
25 to 28	2%
>28	7%

	Count	% of Total
Particles Staying	6940	7%
Particles Leaving	92497	93%

Color Scale Shows % of Parcels Exiting Region



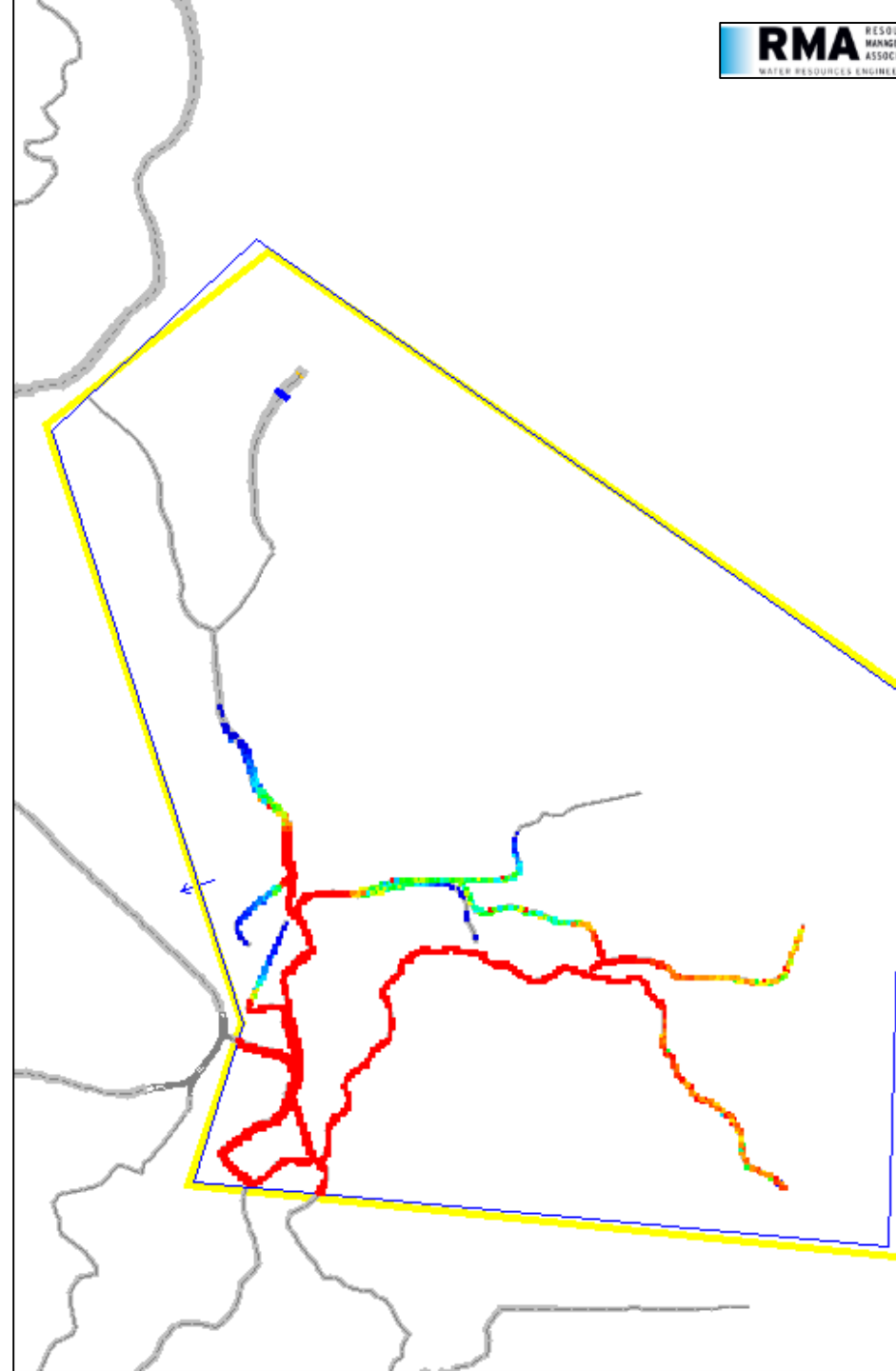
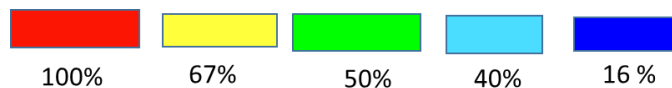
Sept. 28, 2010 23:45  
Eastside Region Fate Map  
99,867 Particles Inserted

(cell size = 50, 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	1%
20 to 25	1%
25 to 28	1%
>28	44%

	Count	% of Total
Particles Staying	44007	44%
Particles Leaving	55860	56%

Color Scale Shows % of Parcels Exiting Region





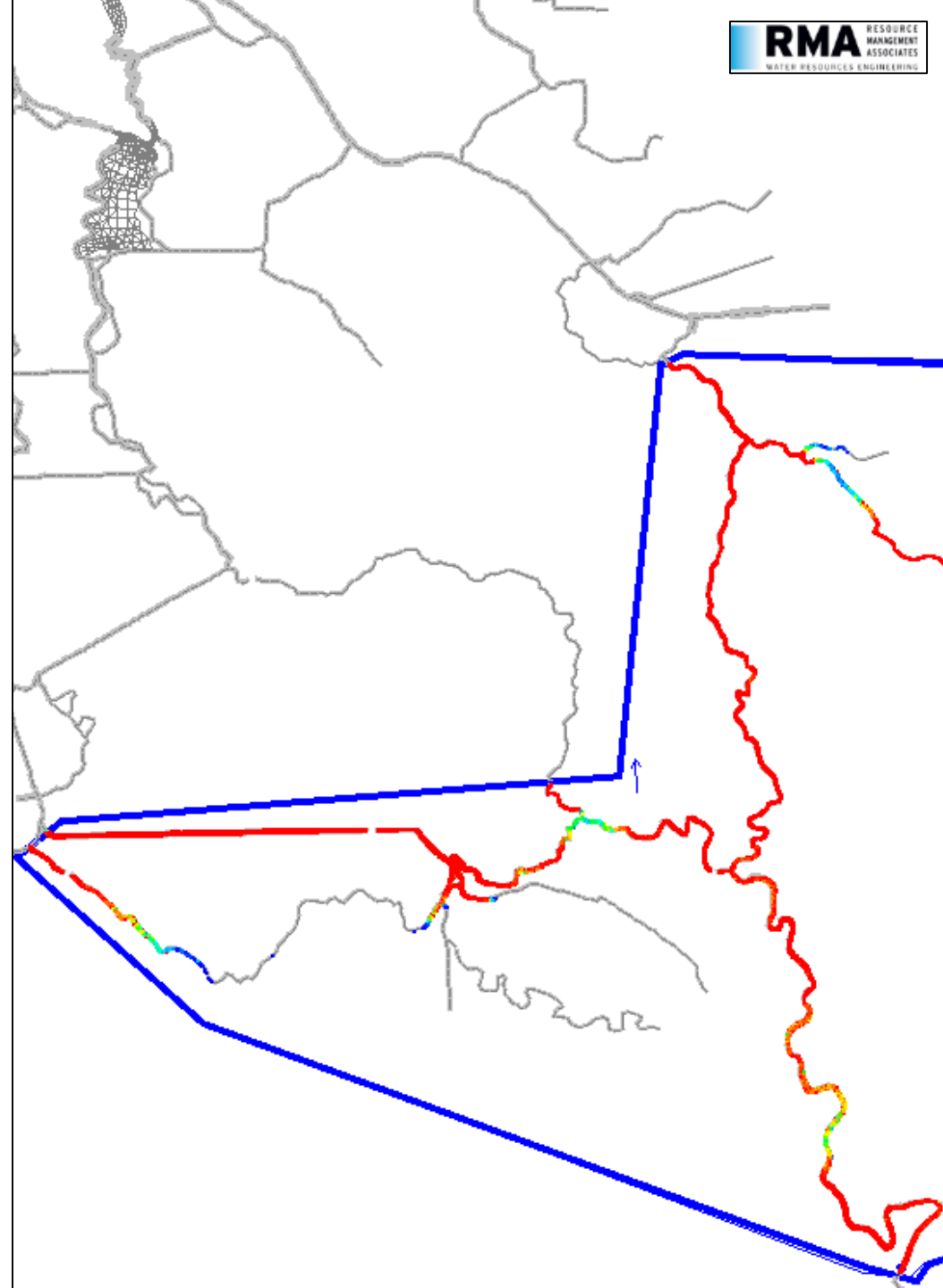
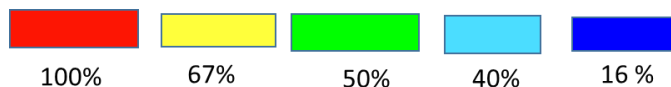
Sept. 28, 2010 23:45  
S. Delta Region Fate Map  
149,828 Particles Inserted

(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	75%
5 to 10	4%
10 to 15	0%
15 to 20	1%
20 to 25	1%
25 to 28	0%
>28	19%

	Count	% of Total
Particles Staying	28104	19%
Particles Leaving	121724	81%

Color Scale Shows % of Parcels Exiting Region



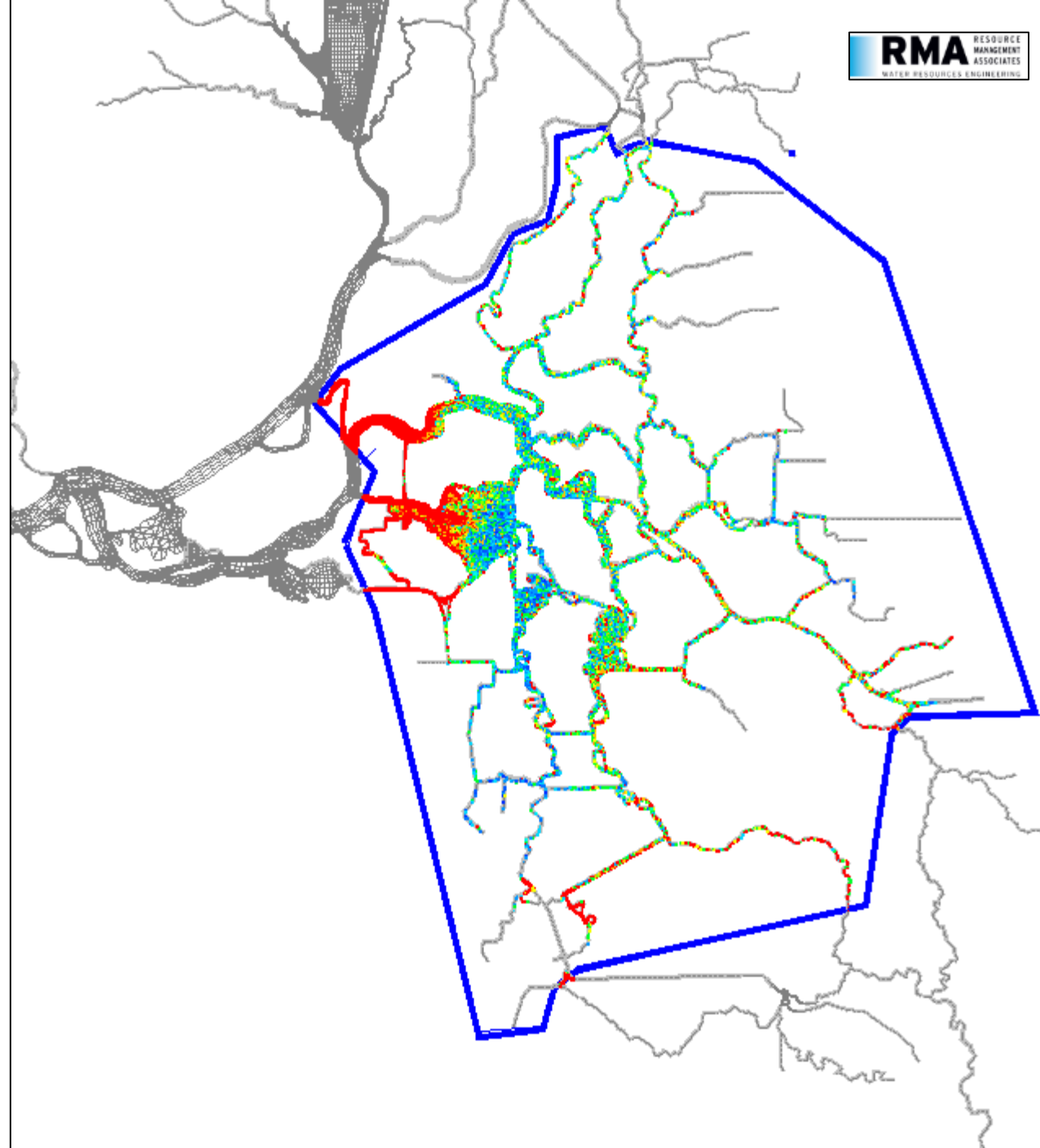
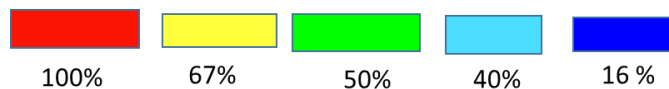
Sept. 28, 2010 23:45  
Central Region Fate Map  
148,790 Particles Inserted

(cell size = 100, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	24%
5 to 10	7%
10 to 15	4%
15 to 20	2%
20 to 25	1%
25 to 28	0%
>28	63%

	Count	% of Total
Particles Staying	93883	63%
Particles Leaving	54907	37%

Color Scale Shows % of Parcels Exiting Region



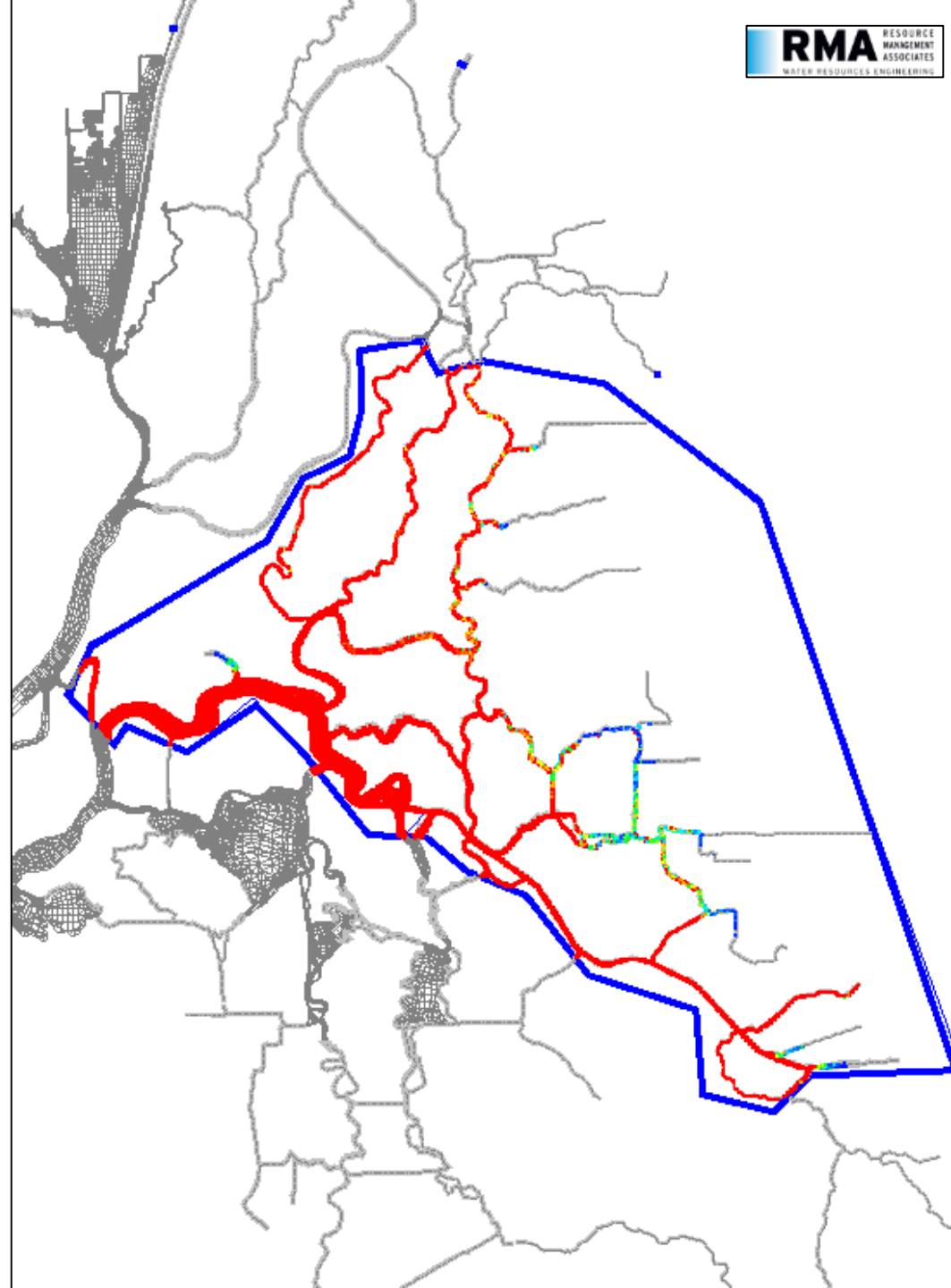
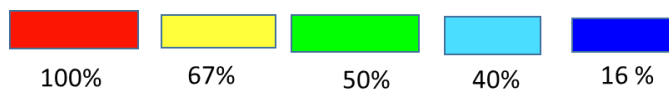
Sept. 28, 2010 23:45  
Central-Upper Region Fate Map

149,504 Particles Inserted  
(cell size = 50, 150,000 particles)

Residence Time in Days	% Particles in Range
0 to 5	59%
5 to 10	19%
10 to 15	8%
15 to 20	2%
20 to 25	1%
25 to 28	0%
>28	11%

	Count	% of Total
Particles Staying	16074	11%
Particles Leaving	133430	89%

Color Scale Shows % of Parcels Exiting Region



Sept. 28, 2010 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	39%
5 to 10	8%
10 to 15	2%
15 to 20	1%
20 to 25	1%
25 to 28	0%
>28	49%

	Count	% of Total
Particles Staying	73501	49%
Particles Leaving	75552	51%

Color Scale Shows % of Parcels Exiting Region

