Structured Decision Making for Delta Smelt:
Demo Project Assessing Resiliency Strategy Actions

CSAMP Meeting

January 31, 2018

Presented by: Graham Long and Sally Rudd, Compass Resource Management

glong@compassrm.com / srudd@compassrm.com

compass

What We Did

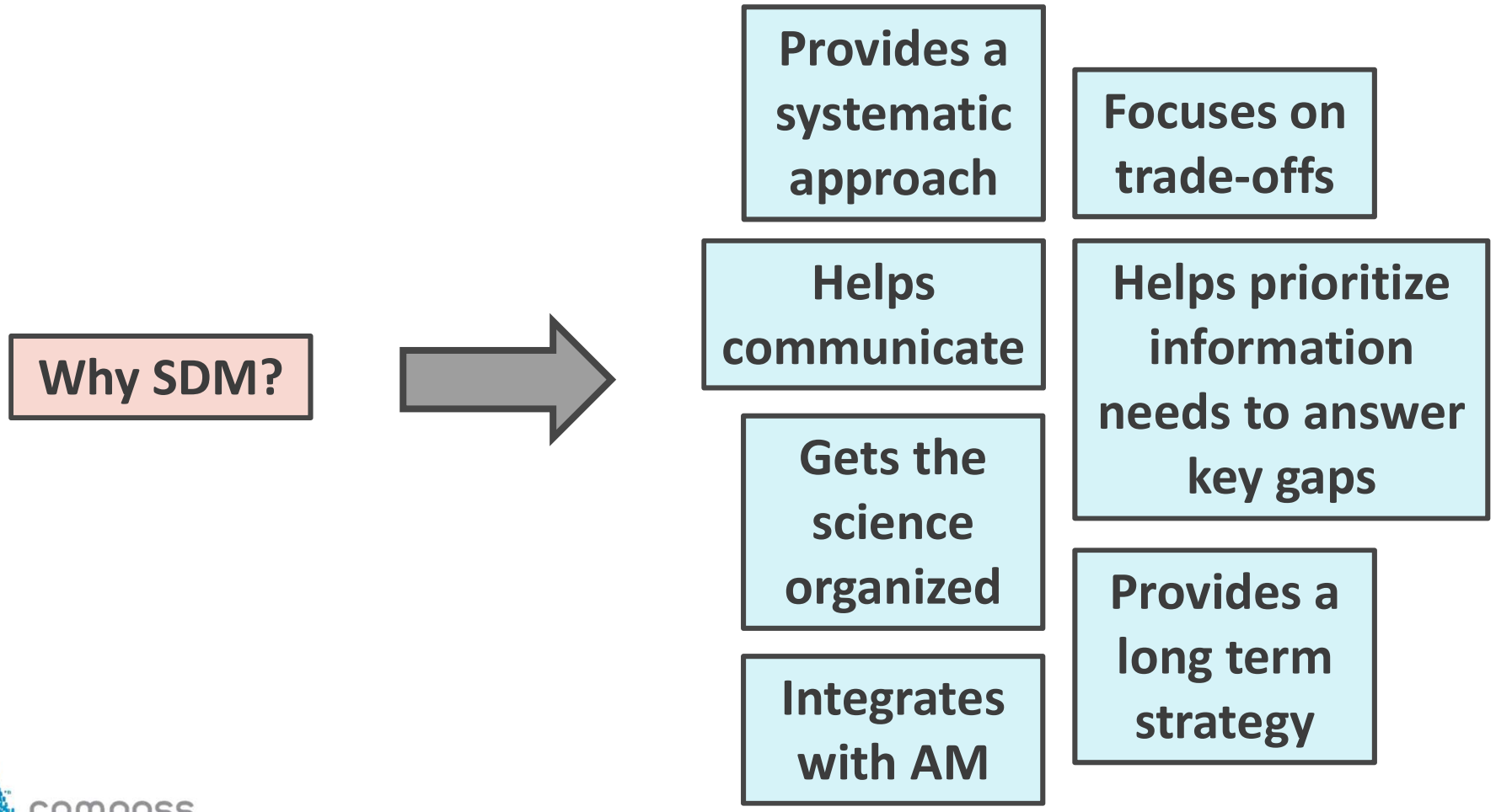
Applied SDM methods to address the question:

Which Delta Smelt Resiliency Strategy actions should be prioritized over the next few years?

Conducted a **coarse-level evaluation** of 13 actions (full build-out, best case scenarios)

compass

Why We Did It



compass

Who Helped

Technical Working Group

Ted Sommer (DWR)
Scott Hamilton (CSD)
Pat Coulston (DFW)
Shawn Acuña (MWD)
Will Smith (FWS)

CAMT SDM Core Team

Carl Wilcox (DFW), Ted Sommer (DWR), Scott Hamilton (CSD), Erin Gleason (FWS), Kaylee Allen (FWS), Cathy Marcinkevage (NOAA), David van Rijn (USBR), Frances Brewster (PWAs), Garwin Yip (NOAA), Maria Rea (NOAA), Gregg Erickson (DFW), Jason Peltier (PWAs), Josh Israel (USBR), Dave Mooney (USBR), Ingram Campbell (DC), Leo Winternitz (NGOs)

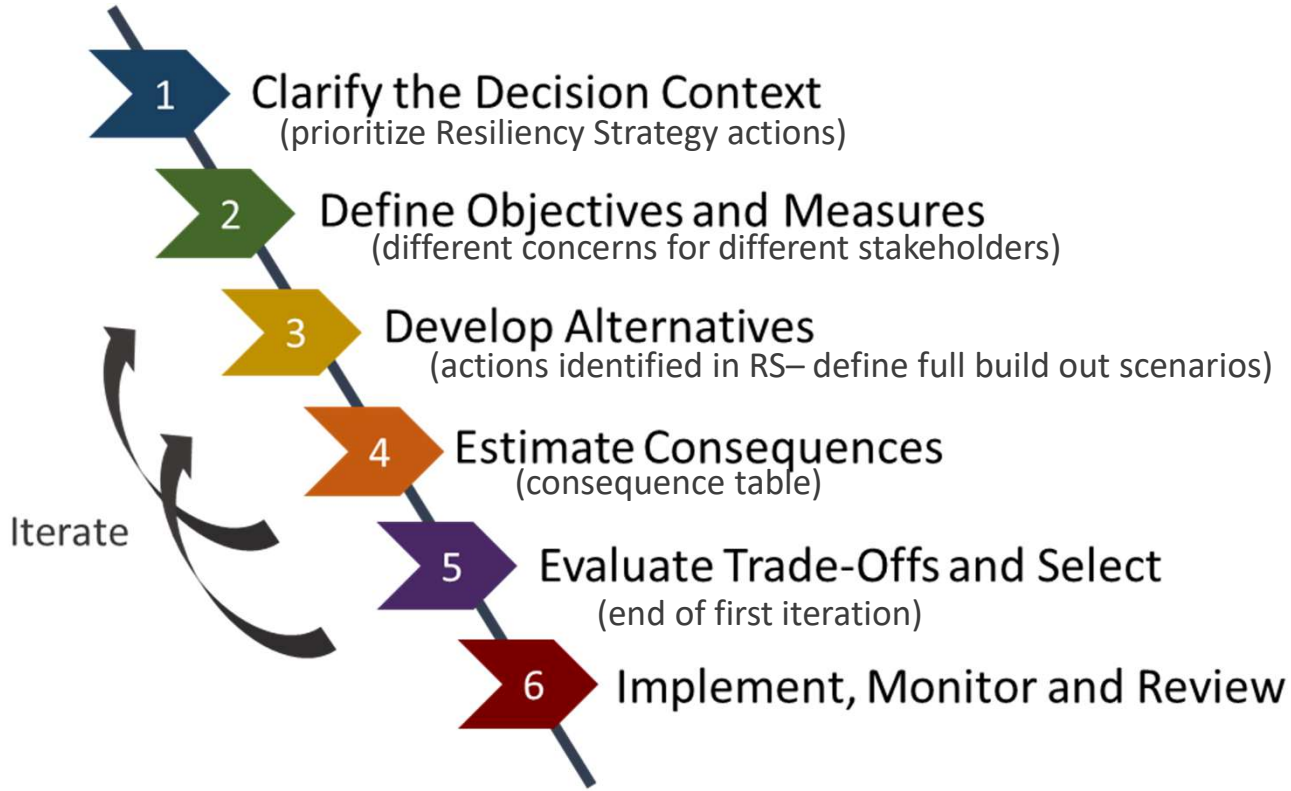
Other Contacts

Louise Conrad (DWR), Eddie Hard (DBW), Brad Cavallo (Cramer), Erik Loboschefsky (DWR), John Durand (UCD), Rosemary Hartman (DFW), April Hennessey (PWAs), Jim Hobbs (UCD), Brett Harvey (DWR), and others.

compass

Approach

Full Build Out Analytical Approach



compass

Define Full Build-out Scenarios

Resiliency Strategy Action	Full Build-out Scenario
Aquatic Weed Control	10,000 ac of aquatic weed control; assumes no adverse impact of herbicides (best case)
North Delta Food Web	24,000 af pulse flows in Jul & Sep in Yolo Bypass
Outflow Augmentation	250 taf to keep X2< 80km for as long as possible in spring/summer
SMSCG Reoperation	Operate gates to make SM as fresh in below normal and dry years as in above normal years; offset salinity increase in Delta with 60 taf
Sediment Supplementation	Increase turbidity in LSZ by 10 NTU in below normal, dry and critical years
Roaring River	Increase connectivity of Roaring River to the estuary and mange to improve food supply
Coordinate Managed Wetlands	Flood and drain 7,500 ac of managed wetlands to improve food
Adjust Fish Salvage Operations	Do not return non-native fish to the Delta from Jul-Sep
Stormwater Management	Reduce contaminant loading into Ulatis Creek Watershed (Cache Slough area) by 50% during winter storm events using constructed wetlands
Rio Vista Research Station	Consolidate existing IEP monitoring and research activities and upgrade refuge population facilities; assumes no population augmentation
Habitat Restoration	11,000 acres of tidal marsh restoration in the north Delta arc
Franks Tract Restoration	Restoration of Franks Tract to establish large areas of emergent marsh; modify flow dynamics

Define Scale and Key Hypothesized Effects of Each Action

Full Build-out Scale Scenario Definition																						
Resiliency Strategy Actions	**Spatial Scale of influence**				**Water Years Implemented (Temporal Scale)**					**Life Stages Benefited (Temporal Scale)**				**Key Means-Objectives**			**Environmental Drivers Affected**					
	Upper Sacramento	**Confluence** (inc. Lower SJ)	**Suisun Marsh**	**Suisun Bay**	**Wet**	**Above Normal**	**Below Normal**	**Dry**	**Critical**	**Eggs/Larvae** Mar-Jun (Spring)	**Juveniles** Jun-Sept (Summer)	**Sub-Adults** Sept-Dec (Fall)	**Adults** Dec-May (Winter)	**Food & Biomass Growth**	**Predation & Survival**	**DS Spatial Distribution**	**Productivity**	**Turbidity**	**Vegetation**	**Salinity**	**Contaminants**	**Predators**
1. Aquatic Weed Control	Y	Y	-	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	-	-	-
2. North Delta Food Web Adaptive Management Projects	-	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	-	Y	-	-	Y	-		-	-	-
3. Outflow Augmentation	Y	Y	Y	Y	-	Y	Y	Y	-	Y	Y	-	-	Y	Y	Y	-	-	-	Y	-	-
4. Reoperation of the Suisun Marsh Salinity Control Gates	-	-	Y	-	-	-	Y	Y	-	-	Y	-	-	Y	Y	Y	-	-	-	Y	-	-
5. Sediment Supplementation in the Low Salinity Zone	-	Y	Y	Y	-	-	Y	Y	Y	Y	Y	-	-	-	Y	-	-	Y	-	-	-	-
7. Roaring River Distribution System Food Production	-	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	Y	-	-	-	-	-
8. Coordinate Managed Wetland Flood and Drain Operations in	-	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	-	Y	-	-	-	-	-
9. Adjust Fish Salvage Operations during Summer and Fall	-	Y	-	-	Y	Y	Y	Y	Y	-	Y	-	-	-	Y	-	-	-	-	-	-	Y
10. Stormwater Discharge Management	Y	-	-	-	Y	Y	Y	Y	Y	-	-	-	Y	Y	-	-	-	-	-	-	Y	-
11. Rio Vista Research Station and Fish Technology Center	N/A																					
12. Near-term Delta Smelt Habitat Restoration	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	Y	-	-	-
13. Franks Tract Restoration Feasibility Study	-	Y	-	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	Y	-	-	Y	-	-	-

Define Objectives – What matters for this decision?

Delta Smelt Population Growth

- Growth (weight)
- Survival (population #s)
- Spawning & recruitment
- Resiliency to random events
- Learning

Other Ecological Considerations

- Salmon
- Other native estuarine species
- Other ecological

Neighbors

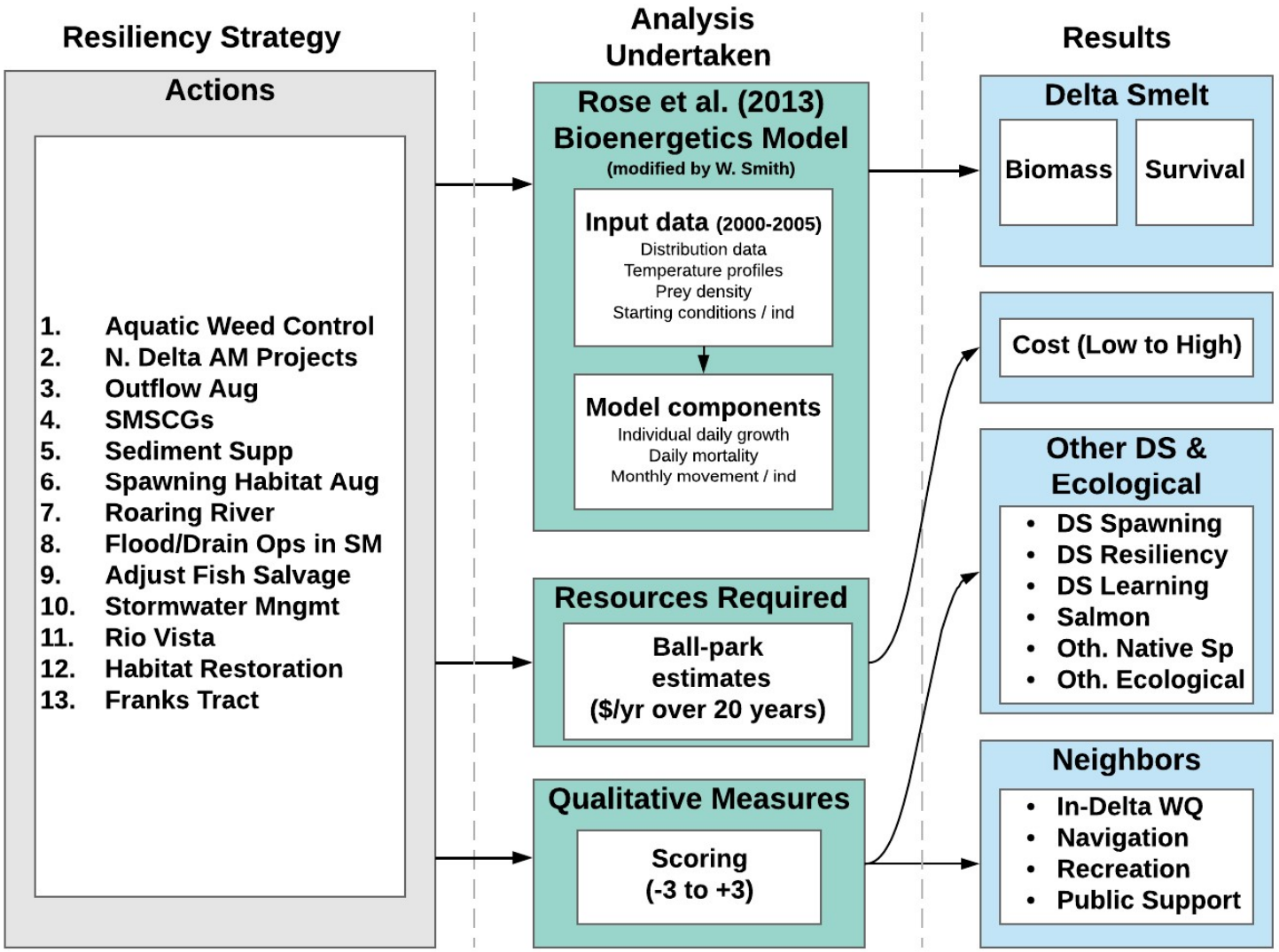
- Water quality for in-Delta diversions
- Navigation
- Recreation
- Local public support

Resources Required

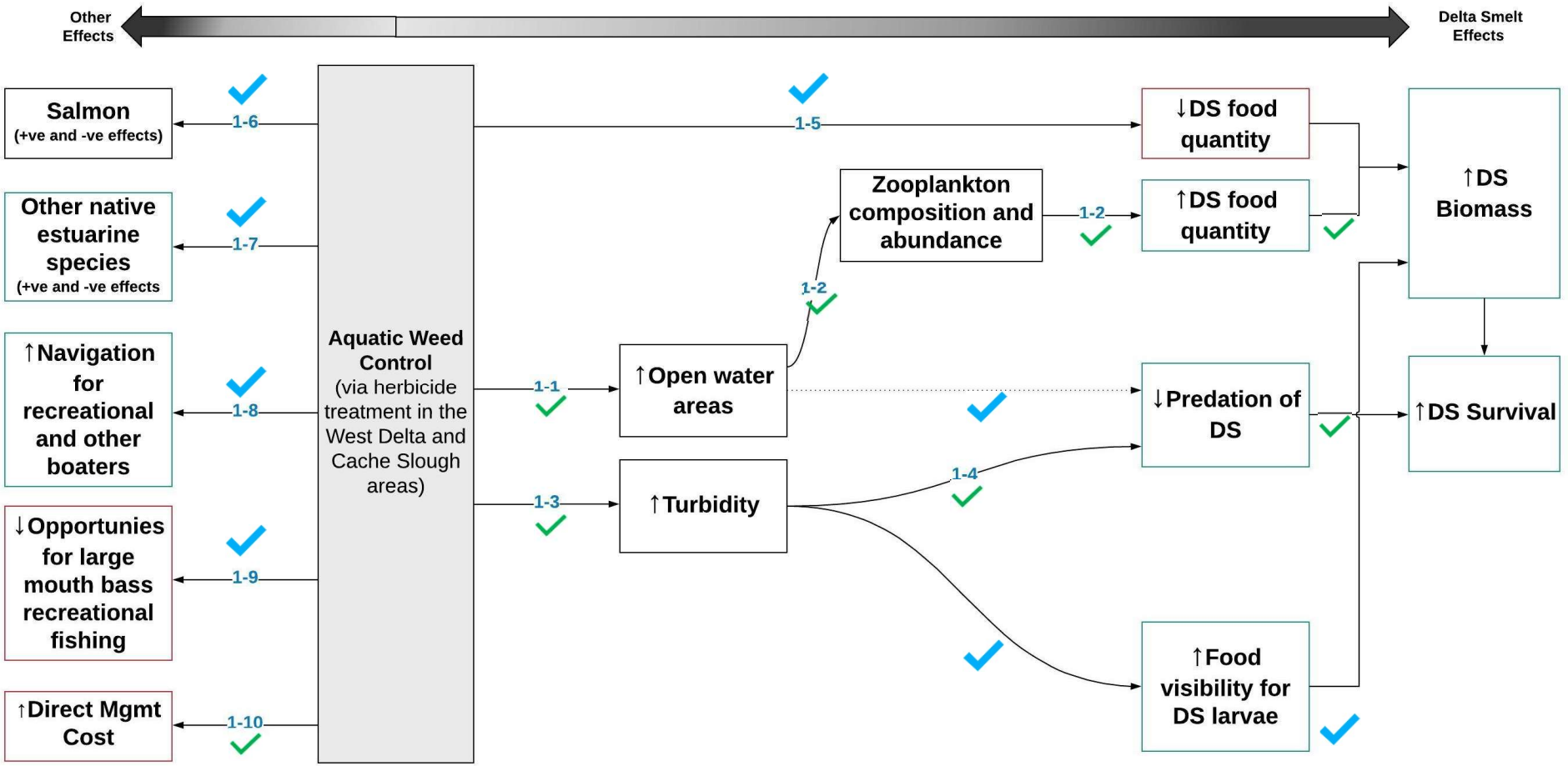
- Financial cost (staff time, upfront/ongoing costs, water costs)

compass

Step 4: Methods to Estimate Consequences



Example: Aquatic Weed Control



compass

✓ Model/quantify pathway

✓ Qualitatively score and/or discuss

What did this work achieve?

- Collaborative process with TWG to populate a consequence table (1st iteration)
- Reached agreement among TWG to recommend binning RS actions into categories:
  1. Continue as planned
  2. Investigate further
  3. Reconsider/drop
- Identified key uncertainties to prioritize for research
- Identified other candidate actions for DS

compass

Findings

(Step 4: Consequences and Step 5: Evaluation)

compass

Important Context

- *Initial* model results based on coarse analyses using *readily* available information
- Have not modeled all DS effect pathways – just 'key' ones
- Sensitivity analyses have not been conducted
- Constructed scales
  - Ecological considerations: 5-person TWG over 4 hours
  - Neighbor effects: Opinion of 1-2 people/action (i.e. very preliminary and likely incomplete)
- Cost estimates are average of high and low estimates

Given all of the above, please refer to TWG members for guidance on the appropriate interpretation of the meaning/significance of results.

compass

How to Read the Consequence Table

Full Build-Out Scale Actions

	Action 1	Action 2	Action 3	…
Objectives (biological, social, economic)				
Objective 1				
Objective 2				
Objective 3				
…				

Consequences / Results (based on model, $ estimates, & scoring)

First Iteration Consequence Table

Certainty in how effects are characterized:
- More certain
- Less certain

	Units	1. Aq. Wd. Control	2. N. Delta Food	3. Out-flow Aug.	4. SMSCG	5. Sed. Supp.	7. Roar. River	8. SM Drain Flood	9. Fish Salv.	10. Storm water	11. Rio Vista	12. Hab. Rest.	13. Franks Tract
DS growth	% change	12%	34%	0%	0%	7%	1%	34%	1%	0%	n/a	7%	1%
DS survival	% change	11%	13%	0%	0%	7%	1%	11%	1%	0%	n/a	3%	1%
DS spawning/recruitment	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.6	0.0	1.5	n/a	2.4	1.2
DS resiliency	-3 to +3	2.8	1.6	1.2	1.4	2.2	0.8	1.4	0.2	0.9	1.3	2.8	1.2
DS learning	-3 to +3	2.2	2.1	1.4	2.1	2.2	1.4	2.0	0.6	1.6	3.0	2.6	1.6
Salmon	-3 to +3	2.3	0.1	1.0	0.0	0.3	0.8	1.0	0.0	1.8	0.3	2.3	1.3
Other native spp	-3 to +3	2.7	2.0	1.7	1.3	0.7	1.0	1.7	0.3	1.7	0.3	3.0	1.3
Other ecological	-3 to +3	3.0	1.3	1.7	1.3	0.7	1.0	1.7	0.3	1.7	0.0	3.0	1.7
Cost/year	$ million	$2.3	$4.2	$46.5	$9.7	$3.8	$0.2	$2.5	$0.9	$7.0	$6.5	$17.9	$17.5
WQ for in-Delta diversions	-3 to +3	0	0	0	0	0	0	0	0	1	0	0	0
Navigation	-3 to +3	3	0	0	0	0	0	0	0	0	0	0	-1
Fishing / waterfowl hunting	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-2
Non-consumptive recreation	-3 to +3	3	0	0	0	0	0	0	0	0	0	3	3

Consequences / Results

compass

First Iteration Consequence Table

Certainty in how effects are characterized:
- More certain
- Less certain

	Units	1. Aq. Wd. Control	2. N. Delta Food	3. Out-flow Aug.	4. SMSCG	5. Sed. Supp.	7. Roar. River	8. SM Drain Flood	9. Fish Salv.	10. Storm water	11. Rio Vista	12. Hab. Rest.	13. Franks Tract
DS growth	% change	12%	34%	0%	0%	7%	1%	34%	1%	0%	n/a	7%	1%
DS survival	% change	11%	13%	0%	0%	7%	1%	11%	1%	0%	n/a	3%	1%
DS spawning/recruitment	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.6	0.0	1.5	n/a	2.4	1.2
DS resiliency	-3 to +3	2.4	2.4	2.2	2.4	2.2	0.8	2.4	0.6	0.9	1.3	2.8	1.2
DS learning	-3 to +3	2.2	2.1	1.4	2.1	2.2	1.4	2.0	0.6	1.6	3.0	2.6	1.6
Salmon	-3 to +3	2.3	0.1	1.0	0.0	0.5	0.8	1.0	0.0	1.8	0.3	2.3	1.3
Other native spp	-3 to +3	2.7	2.0	1.7	1.3	1.0	0.7	1.0	0.3	1.7	0.3	3.0	1.3
Other ecological	-3 to +3	3.0	1.3	1.7	1.3	0.7	1.0	1.7	0.3	1.7	0.0	3.0	1.7
Cost/year	$ million	$2	$1	$1	$1	$1	$1	$2	$2.5	$0.9	$7.0	$6.5	$17.9	$17.5
WQ for in-Delta diversions	-3 to +3	0	0	0	0	0	0	0	0	1	0	0	0
Navig.	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-1
Fishing / waterfowl hunting	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-2
Non-consumptive recreation	-3 to +3	3	0	0	0	0	0	0	0	0	0	3	3

Initial model results based on *readily* available information.

Only modeled *key* DS effect pathways.

Metric is the % change in average growth or survival from a 6-year modeled reference period (2000-2005).

Use model results to compare *relative* performance of actions for DS growth and survival.

compass

First Iteration Consequence Table

Certainty in how effects are characterized:
- More certain
- Less certain

	Units	1. Aq. Wd. Control	2. N. Delta Food	3. Out-flow Aug.	4. SMSCG	5. Sed. Supp.	7. Roar. River	8. SM Drain Flood	9. Fish Salv.	10. Storm water	11. Rio Vista	12. Hab. Rest.	13. Franks Tract
DS growth	% change	12%	34%	0%	0%	7%	1%	34%	1%	0%	n/a	7%	1%
DS survival	% change	11%	13%	0%	0%	7%	1%	11%	1%	0%	n/a	3%	1%
DS spawning/recruitment	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.6	0.0	1.5	n/a	2.4	1.2
DS resiliency	-3 to +3	2.8	1.6	1.2	1.4	2.2	0.8	1.4	0.2	0.9	1.3	2.8	1.2
DS learning	-3 to +3	2.2	2.1	1.4	2.1	2.2	1.4	2.0	0.6	1.6	3.0	2.6	1.6
Salmon	-3 to +3	2.3	0.1	1.0	0.0	0.3	0.8	1.0	0.0	1.8	0.3	2.3	1.3
Other native spp	-3 to +3	2.7	2.0	1.7	1.3	1.0	0.7	1.0	0.3	1.7	0.3	3.0	1.3
Other ecological	-3 to +3	2.7	2.0	1.7	1.3	1.0	0.7	1.7	0.3	1.7	0.0	3.0	1.7
Cost/year	$ million	$2.3	$4.2	$46.5	$9.7	$3.8	$0.2	$2.5	$0.9	$7.0	$6.5	$17.9	$17.5
WQ for in-Delta diversions	-3 to +3	0	0	0	0	0	0	0	0	1	0	0	0
Navigation	-3 to +3	3	0	0	0	0	0	0	0	0	0	0	-1
Fishing / waterfowl hunting	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-2
Non-consumptive recreation	-3 to +3	3	0	0	0	0	0	0	0	0	0	3	3

Need more work:

Only included one key effect pathway.

Not predicted to increase DS growth/survival *based on our current assumptions.*

compass

First Iteration Consequence Table

Certainty in how effects are characterized:
- More certain
- Less certain

For -3 to +3 scales

<<<===Larger adverse impact		Small adverse impact	No effect	Small benefit	Larger benefit===>>>	
-3	-2	-1	0	1	2	3

	Units	1. Aq. Wd. Control	2. N. Delta Food	3. Out-flow Aug.	4. SMSCG	5. Sed. Supp.	7. Roar. River	8. SM Drain Flood	9. Fish Salv.	10. Storm water	11. Rio Vista	12. Hab. Rest.	13. Franks Tract
DS growth	% change	12%	34%	0%	0%	7%	1%	34%	1%	0%	n/a	7%	1%
DS survival	% change	11%	13%	0%	0%	7%	1%	11%	1%	0%	n/a	3%	1%
DS spawning/recruitment	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.6	0.0	1.5	n/a	2.4	1.2
DS resiliency	-3 to +3	2.8	1.6	1.2	1.4	2.2	0.8	1.4	0.2	0.9	1.3	2.8	1.2
DS learning	-3 to +3	2.2	2.1	1.4	2.1	2.2	1.4	2.0	0.6	1.6	3.0	2.6	1.6
Salmon	-3 to +3	2.3	0.1	1.0	0.0	0.3	0.8	1.0	0.0	1.8	0.3	2.3	1.3
Other native spp	-3 to +3	2.7	2.0	1.7	1.3	1.0	0.7	1.0	0.3	1.7	0.3	3.0	1.3
Other ecological	-3 to +3	3.0	1.3	1.7	1.3	0.7	1.0	1.7	0.3	1.7	0.0	3.0	1.7
Cost/year	$ million	$2.3	$4.2	$46.5	$9.7	$3.8	$0.2	$2.5	$0.9	$7.0	$6.5	$17.9	$17.5
WQ for in-Delta diversions	-3 to +3	0	0	0	0	0	0	0	0	1	0	0	0
Navigation	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-1
Fishing / waterfowl hunting	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-2
Non-consumptive recreation	-3 to +3	3	0	0	0	0	0	0	0	0	0	3	3

Ecological scores are an average from TWG and guests.

compass

First Iteration Consequence Table

Certainty in how effects are characterized:
- More certain
- Less certain

	Units	1. Aq. Wd. Control	2. N. Delta Food	3. Out-flow Aug.	4. SMSCG	5. Sed. Supp.	7. Roar. River	8. SM Drain Flood	9. Fish Salv.	10. Storm water	11. Rio Vista	12. Hab. Rest.	13. Franks Tract
DS growth	% change	12%	34%	0%	0%	7%	1%	34%	1%	0%	n/a	7%	1%
DS survival	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.6	0.0	1.5	n/a	2.4	1.2
DS spawning/recruitment	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.6	0.0	1.5	n/a	2.4	1.2
DS resiliency	-3 to +3	2.8	1.6	1.2	1.4	2.2	0.8	1.4	0.2	0.9	1.3	2.8	1.2
DS learning	-3 to +3	2.2	2.1	1.4	2.1	2.2	1.4	2.0	0.6	1.6	3.0	2.6	1.6
Salmon	-3 to +3	2.7	0.1	1.8	0.6	0.5	0.8	1.6	0.0	1.8	0.3	2.3	1.3
Other native spp	-3 to +3	2.7	2.0	1.7	1.3	1.0	0.7	1.0	0.3	1.7	0.3	3.0	1.3
Other ecological	-3 to +3	3.0	1.3	1.7	1.3	0.7	1.0	1.7	0.3	1.7	0.0	3.0	1.7
Cost/year	$ million	$2.3	$4.2	$46.5	$9.7	$3.8	$0.2	$2.5	$0.9	$7.0	$6.5	$17.9	$17.5
WQ for in-Delta diversions	-3 to +3	0	0	0	0	0	0	0	0	1	0	0	0
Navigation	-3 to +3	3	0	0	0	0	0	0	0	0	0	0	-1
Fishing / waterfowl hunting	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-2
Non-consumptive recreation	-3 to +3	3	0	0	0	0	0	0	0	0	0	3	3

Capital and operating costs for each action were annualized over a 20-year period with consideration of the frequency and duration of each action over this period.

Averages of high and low annual cost estimates are shown.

compass

First Iteration Consequence Table

Certainty in how effects are characterized:
- More certain
- Less certain

For -3 to +3 scales

<<<===Larger adverse impact		Small adverse impact	No effect	Small benefit	Larger benefit===>>>	
-3	-2	-1	0	1	2	3

	Units	1. Aq. Wd. Control	2. N. Delta Food	3. Out-flow Aug.	4. SMSCG	5. Sed. Supp.	7. Roar. River	8. SM Drain Flood	9. Fish Salv.	10. Storm water	11. Rio Vista	12. Hab. Rest.	13. Franks Tract
DS growth	% change	12%	34%	0%	0%	7%	1%	34%	1%	0%	n/a	7%	1%
DS survival	% change	11%	13%	0%	0%	7%	1%	11%	1%	0%	n/a	3%	1%
DS spawning/recruitment	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.0	0.0	1.5	n/a	2.4	1.2
DS resiliency	-3 to +3	2.8	1.6	1.2	1.4	2.2	0.8	1.4	0.2	0.9	1.3	2.8	1.2
DS learning	-3 to +3	2.4	1.4	1.4	1.4	1.4	0.8	1.4	0.2	1.6	1.3	2.6	1.6
Salmon	-3 to +3	2.3	0.1	1.0	0.0	0.3	0.8	1.0	0.0	1.8	0.3	2.3	1.3
Other native spp	-3 to +3	2.7	2.0	1.7	1.3	1.0	0.7	1.0	0.3	1.7	0.3	3.0	1.3
Other ecological	-3 to +3	3.0	1.3	1.7	1.3	0.7	1.0	1.7	0.3	1.7	0.0	3.0	1.7
Cost/year	$ million	$2.3	$4.2	$46.5	$9.7	$3.8	$0.2	$2.5	$0.9	$7.0	$6.5	$17.9	$17.5
WQ for in-Delta diversions	-3 to +3	0	0	0	0	0	0	0	0	1	0	0	0
Navigation	-3 to +3	3	0	0	0	0	0	0	0	0	0	0	-1
Fishing / waterfowl hunting	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-2
Non-consumptive recreation	-3 to +3	3	0	0	0	0	0	0	0	0	0	3	3

Each neighbors score reflects the opinions of 1-2 people.

These rows received the least effort – included here for *illustrative* purposes only.

Broader vetting needed.

compass

First Iteration Consequence Table

	Units	1. Aq. Wd. Control	2. N. Delta Food	3. Out-flow Aug.	4. SMSCG	5. Sed. Supp.	7. Roar. River	8. SM Drain Flood	9. Fish Salv.	10. Storm water	11. Rio Vista	12. Hab. Rest.	13. Franks Tract
DS growth	% change	12%	34%	0%	0%	7%	1%	34%	1%	0%	n/a	7%	1%
DS survival	% change	11%	13%	0%	0%	7%	1%	11%	1%	0%	n/a	3%	1%
DS spawning/recruitment	-3 to +3	2.4	0.0	0.6	0.4	0.8	0.8	1.6	0.0	1.5	n/a	2.4	1.2
DS resiliency	-3 to +3	2.8	1.6	1.2	1.4	2.2	0.8	1.4	0.2	0.9	1.3	2.8	1.2
DS learning	-3 to +3	2.2	2.1	1.4	2.1	2.2	1.4	2.0	0.6	1.6	3.0	2.6	1.6
Salmon	-3 to +3	2.3	0.1	1.0	0.0	0.3	0.8	1.0	0.0	1.8	0.3	2.3	1.3
Other native spp	-3 to +3	2.7	2.0	1.7	1.3	1.0	0.7	1.0	0.3	1.7	0.3	3.0	1.3
Other ecological	-3 to +3	3.0	1.3	1.7	1.3	0.7	1.0	1.7	0.3	1.7	0.0	3.0	1.7
Cost/year	$ million	$2.3	$4.2	$46.5	$9.7	$3.8	$0.2	$2.5	$0.9	$7.0	$6.5	$17.9	$17.5
WQ for in-Delta diversions	-3 to +3	0	0	0	0	0	0	0	0	1	0	0	0
Navigation	-3 to +3	3	0	0	0	0	0	0	0	0	0	0	-1
Fishing / waterfowl hunting	-3 to +3	0	0	0	0	0	0	0	0	0	0	0	-2
Non-consumptive recreation	-3 to +3	3	0	0	0	0	0	0	0	0	0	3	3

Certainty in how effects are characterized:
- More certain
- Less certain

For -3 to +3 scales

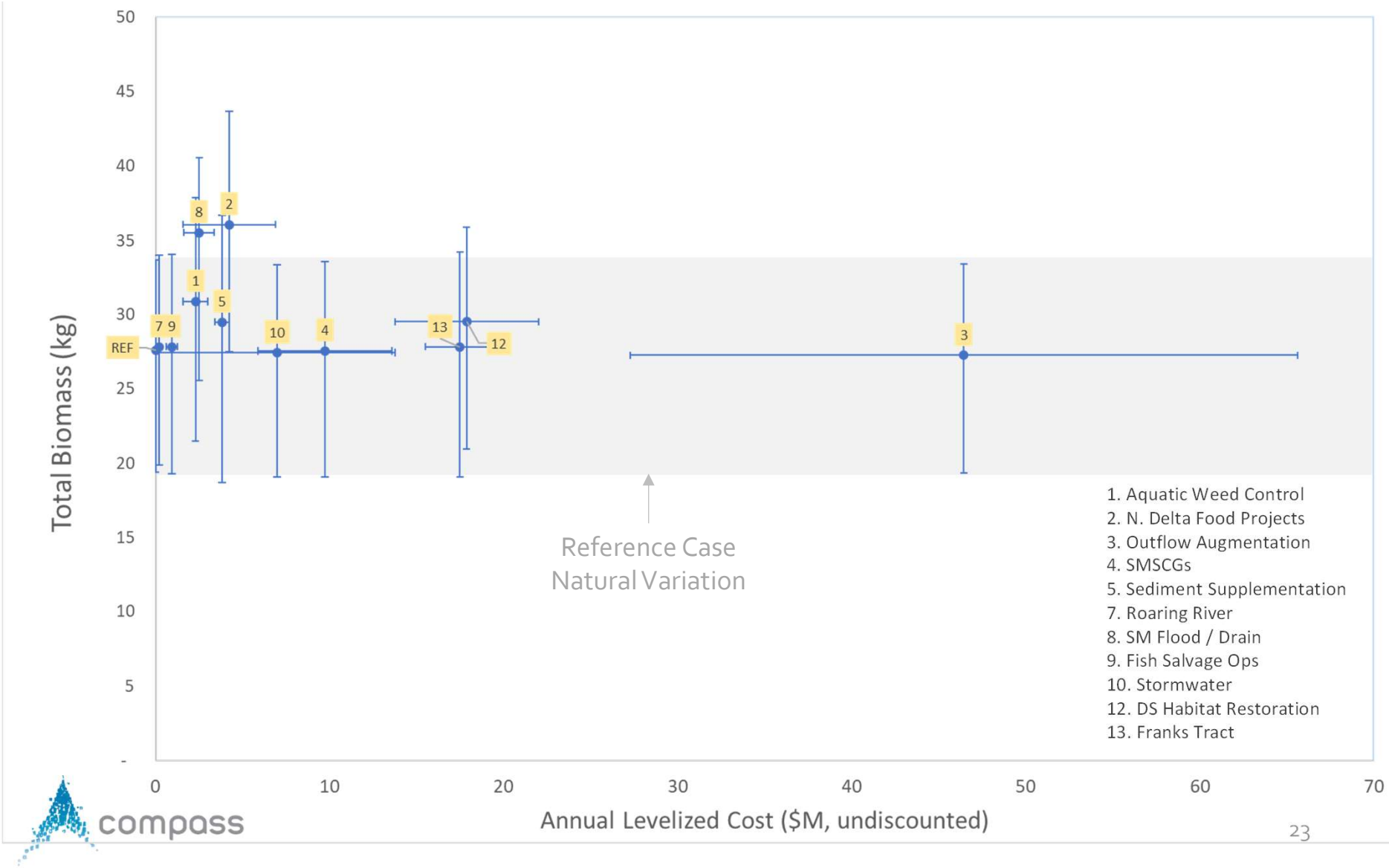
<<<===Larger adverse impact		Small adverse impact	No effect	Small benefit	Larger benefit===>>>	
-3	-2	-1	0	1	2	3

compass

Color coding shows highest to lowest values within each row (Green = benefit; Red = cost).

Benefits vs. Costs

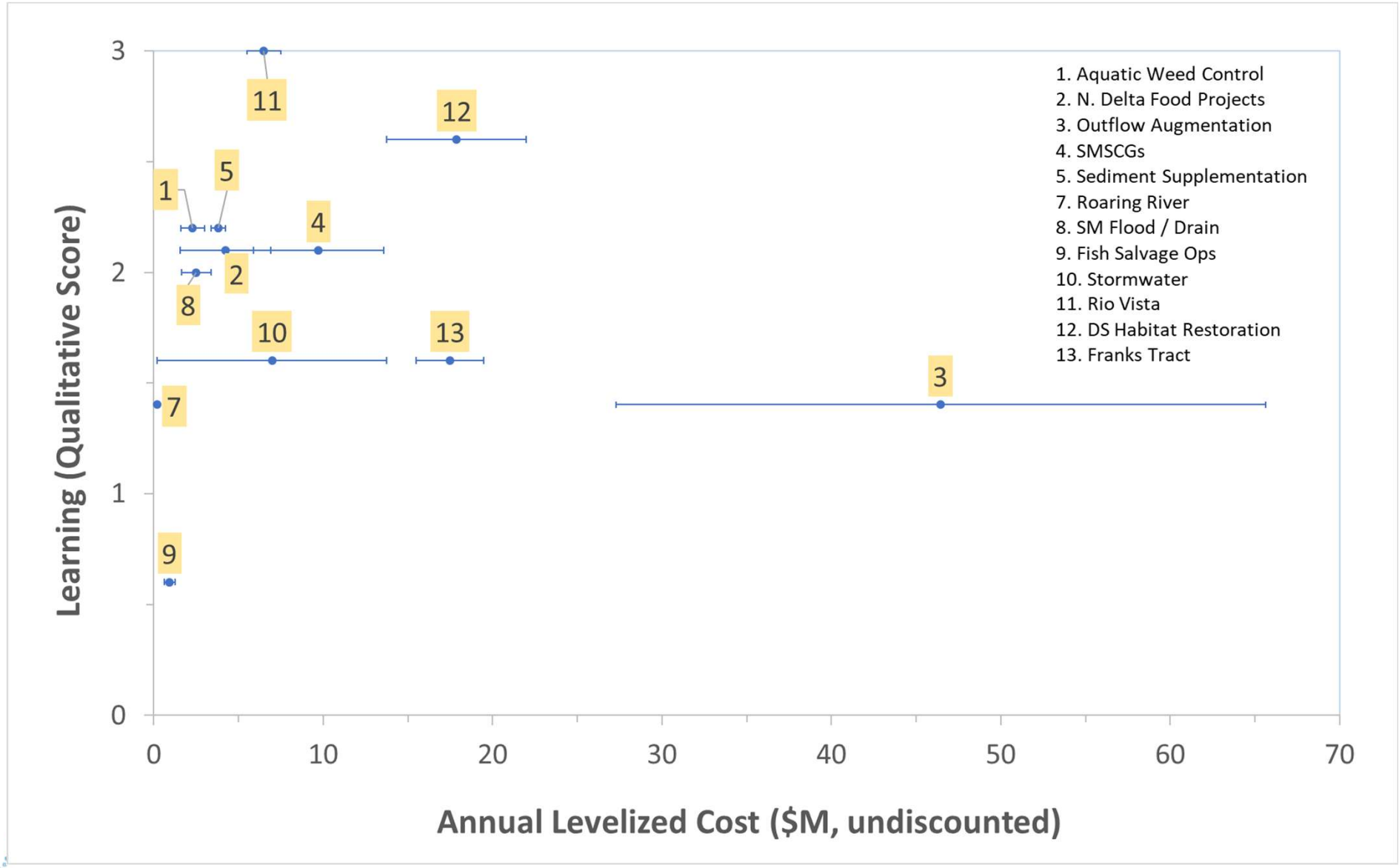
Example 1: Total Biomass vs. Annual Levelized Cost



compass

Benefits vs. Costs

Example 2: Learning vs. Annual Levelized Cost



Suggested Interpretation of First Iteration

Continue as planned

2. North Delta Food Web
4. Suisun Marsh Salinity Control Gates
8. Managed Wetland Flood/Drain Operations
7. Roaring River Distribution System
12. Near-term DS Habitat Restoration
11. Rio Vista Research Station and FTC

Investigate further

1. Aquatic Weed Control
3. Outflow Augmentation
5. Sediment Supplementation in the LSZ
10. Stormwater Management
13. Franks Tract

Reconsider

6. Spawning Habitat Augmentation
9. Adjust Fish Salvage Operations

Certainty in how effects are characterized:

- More certain
- Less certain

compass

Continue as planned?

Higher priority actions: relatively high confidence in relatively high benefit / cost ratios

Action	Rationale for being in this category
2.North Delta Food Web	• High food and survival benefit, low cost
8. Wetland Flood and Drain Ops	• High food and survival benefit, low cost
12.DS Habitat Restoration	• Long term habitat benefits, despite higher costs
11.Rio Vista Research Station / FTC	• High learning, despite higher costs; • Also potential for population augmentation (not evaluated in this exercise)
4. SMSCGs	• Uncertain benefit but low cost* and learning potential
7. Roaring River Food Production	• Lower benefit but low cost, synergy with managed wetlands

Certainty in how effects are characterized:
- More certain
- Less certain

*Low cost on account of new analysis received after production of the 1st iteration consequence table that the SMSCG would likely not require 60 TAF outflow augmentation.

Investigate further?

Actions that warrant further analysis before benefit / cost ratio can more confidently be judged

Action	Rationale for being in this category
5. Sediment Supplementation	• Turbidity benefits and costs moderate • Hurdles include permitting and sourcing sediment
1. Aquatic Weed Control	• Many ecological benefits at moderate cost • Questions about: feasibility at large scale and managing risk perception
3. Outflow Augmentation	• Action cost is relatively high • Initial bioenergetics modeling shows low benefit, however other potentially important pathways remain unexplored, and substantial uncertainties exist regarding the fish distribution response to the action
10. Stormwater Mgmt	• Specific benefits poorly understood, high cost if land is purchased
13. Franks Tract	• Modest benefits / high cost and negatives to stakeholders • May be other pathways to explore

compass

Certainty in how effects are characterized:
- More certain
- Less certain

Reconsider?

Relatively high confidence that there would be low or no benefit

Action	Rationale for being in this category
6. Spawning Habitat Augmentation	• Adding sand unlikely to make effective spawning habitat
9. Adjust Fish Salvage Operations in Summer and Fall	• Likely minimal benefit

compass

Certainty in how effects are characterized:
- More certain
- Less certain

What’s next?

compass

Proposed Next Steps

Wrap Up this Demo Project with TWG

- Document this process (mostly complete)

Proposed Follow-up Process

- 2-day planning workshop to develop a process plan

compass

The Demo…

Did:

- Examine proposed RS Actions
- Give guidance on prioritizing actions in the short-medium term
- Collect input and perform analyses with a small TWG

Did not:

- Dive deeply into underlying debates about cause and effect
- Create a long-term framework for implementing/testing actions
- Perform extensive engagement with a wide range of parties

However, these could be next steps in a follow-up process that could ultimately look like…

compass

A First Step: Scoping Workshop?

Purpose: To scope an SDM process to identify and evaluate a comprehensive set of strategic actions to significantly benefit DS

- 2-day workshop
- First half day with senior decision-makers
  - Work through first steps of SDM
  - Discuss: needs, scale, timeline, resources
  - Share example: Missouri River AM Plan
- Next 1.5 days – working sessions
  - Design an integrative process with managers, program leads, and stakeholders

compass

A First Step: A Planning Workshop?

Purpose: To scope an SDM process to identify and evaluate a comprehensive set of strategic actions to significantly benefit DS

Present results of the workshop to

CAMT + Policy Group to consider proposal

compass

Extra Slides

Example:
Missouri River Recovery Program

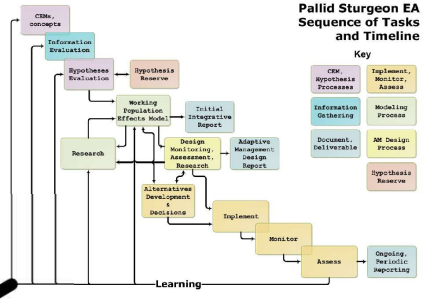
- USACE
- 3 ESA-listed spp
- Major science uncertainties
- EIS on actions
- MRRIC engagement
- A hybrid of SDM and standard processes

compass

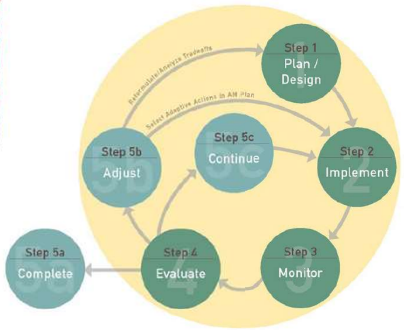
Example:
Missouri River Recovery Program

SDM Process

Effects Analysis



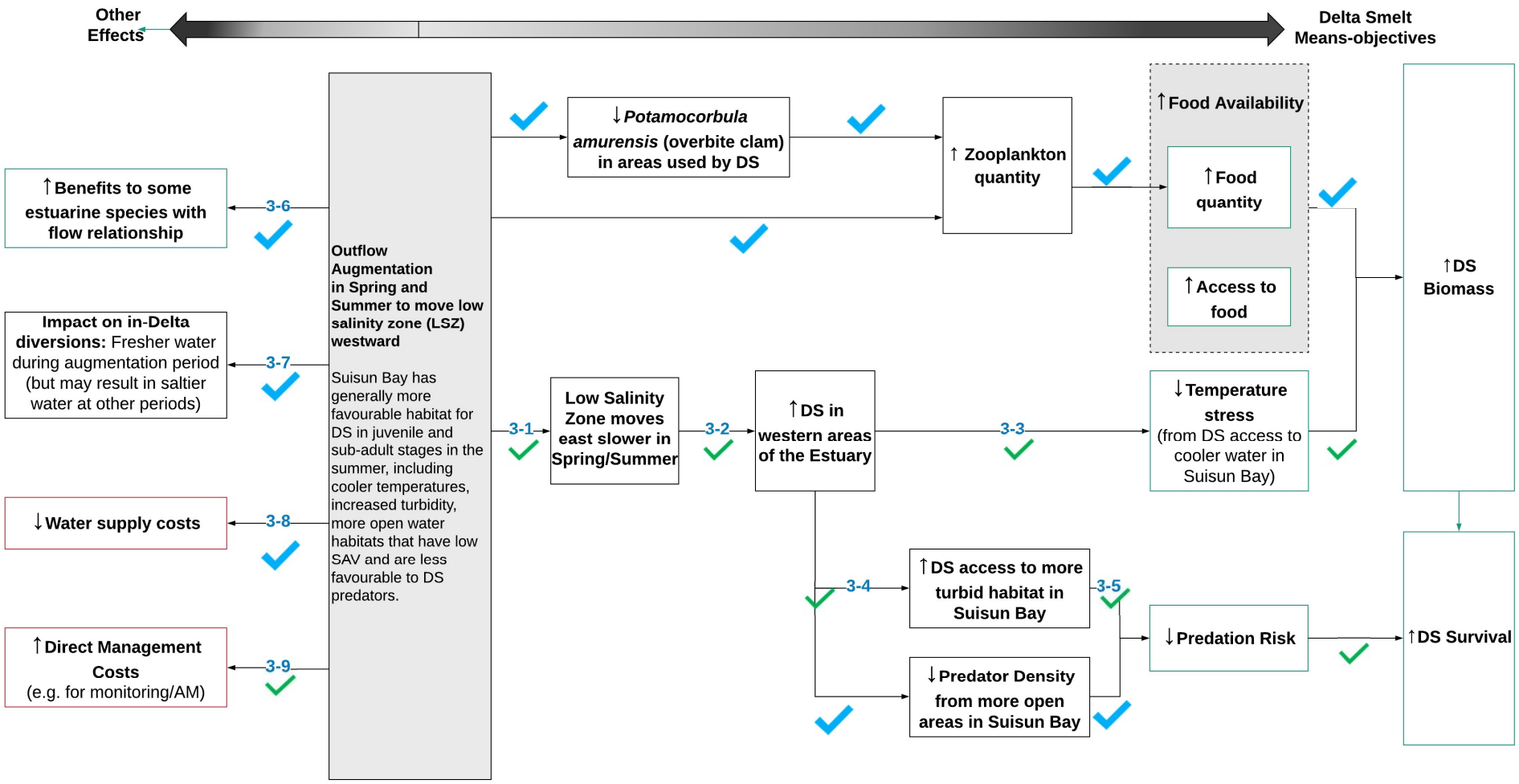
15-year Management Plan Selected from Consequence Table



Adaptive Management Plan

compass

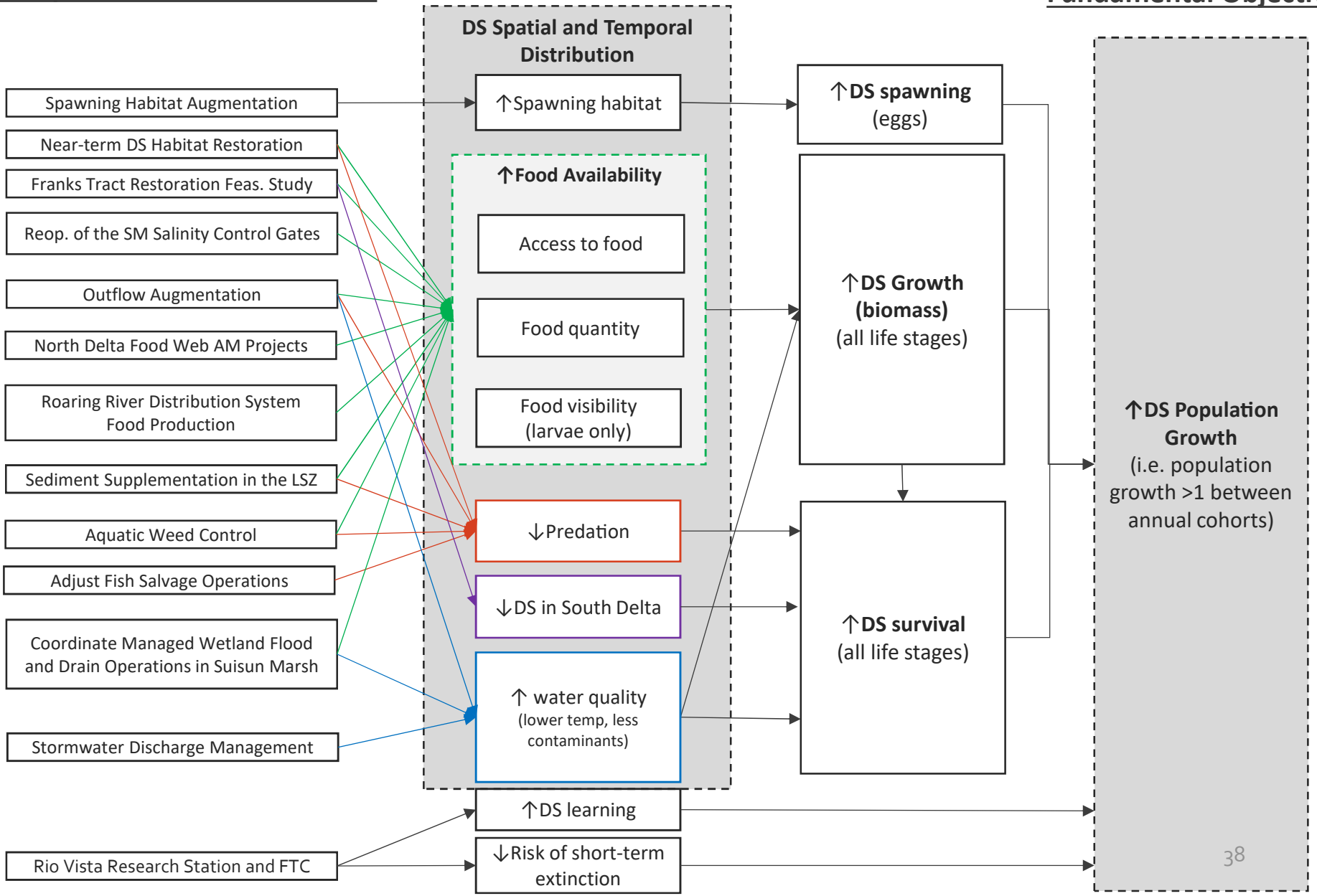
Outflow Augmentation



compass

✓ Model/quantify pathway

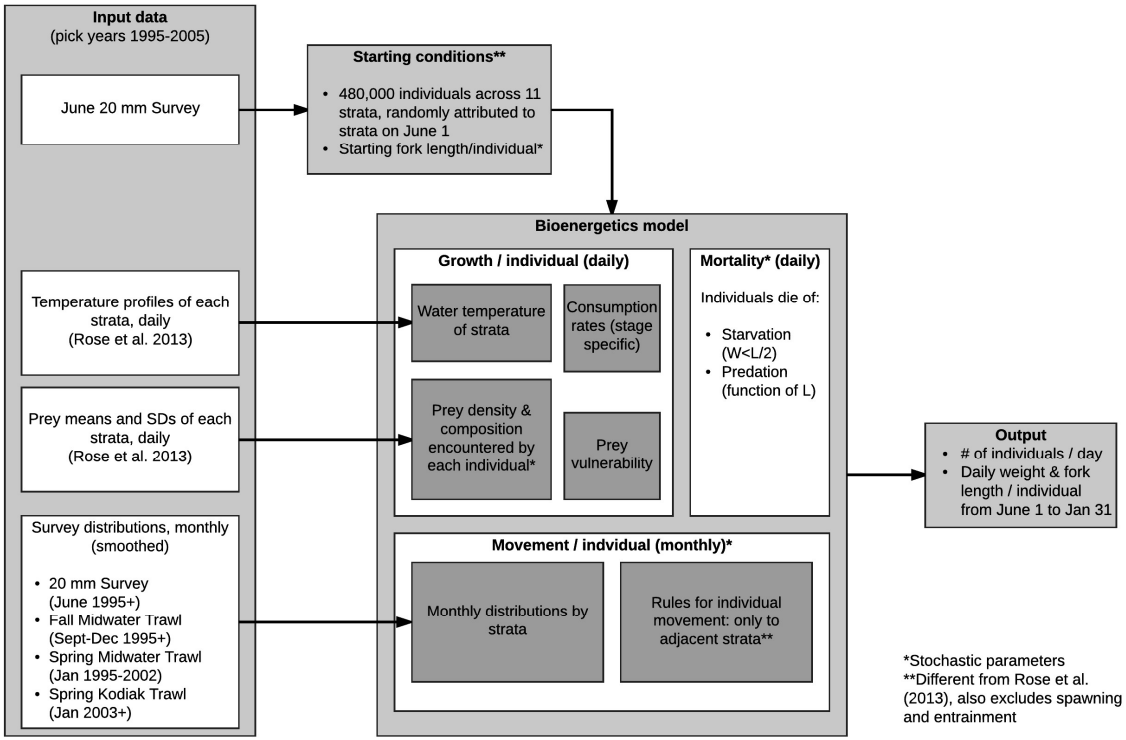
✓ Qualitatively score and/or discuss


Resiliency Strategy Actions to improve Delta smelt Habitat
Delta smelt Means-objectives
Delta smelt Fundamental Objective
DS Spatial and Temporal Distribution
Spawning Habitat Augmentation
Near-term DS Habitat Restoration
Franks Tract Restoration Feas. Study
Reop. of the SM Salinity Control Gates
Outflow Augmentation
North Delta Food Web AM Projects
Roaring River Distribution System Food Production
Sediment Supplementation in the LSZ
Aquatic Weed Control
Adjust Fish Salvage Operations
Coordinate Managed Wetland Flood and Drain Operations in Suisun Marsh
Stormwater Discharge Management
Rio Vista Research Station and FTC
↑Spawning habitat
↑Food Availability
Access to food
Food quantity
Food visibility (larvae only)
↓Predation
↓DS in South Delta
↑ water quality (lower temp, less contaminants)
↑DS learning
↓Risk of short-term extinction
↑DS spawning (eggs)
↑DS Growth (biomass) (all life stages)
↑DS survival (all life stages)
↑DS Population Growth (i.e. population growth >1 between annual cohorts)

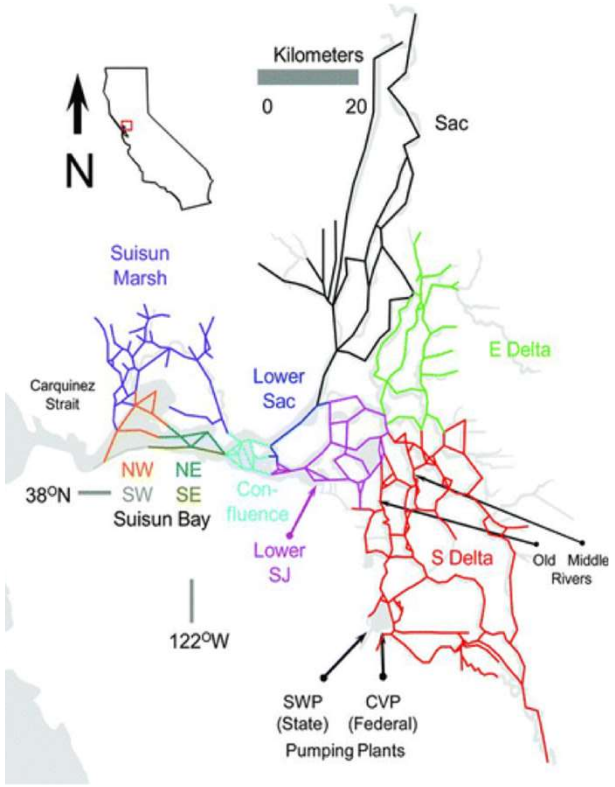
Delta Smelt Bio-energetics Model

Modified from Rose et al. (2013)

Model Schematic



Model Strata



Model coded and run by: Will Smith (FWS)