Indian River Lagoon

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Seagrasses

- Key to ecology & management
- Ecological roles
  - habitat (> 80% of valued fish use)
  - food (endangered manatee & sea turtles)
  - water quality (nutrients & sediment)
- Management role as TMDL metric
  - nutrients $\Downarrow \Rightarrow$ phytoplankton $\Downarrow \Rightarrow$ water clarity $\Uparrow \Rightarrow$ light penetration $\Uparrow \Rightarrow$ seagrass “happy” $\Rightarrow$ system “happy”

Nutrient impairment

BASIN MANAGEMENT ACTION PLAN

for the Implementation of Total Maximum Daily Loads for Nutrients
Adopted by the Florida Department of Environmental Protection

in the

Indian River Lagoon Basin
Banana River Lagoon

developed by the
Banana River Lagoon Stakeholders

in cooperation with the
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration
Tallahassee, Florida 32399

January 2013

BASIN MANAGEMENT ACTION PLAN

for the Implementation of Total Maximum Daily Loads for Nutrients
Adopted by the Florida Department of Environmental Protection

in the

Indian River Lagoon Basin
Central Indian River Lagoon

developed by the
Central Indian River Lagoon Stakeholders

in cooperation with the
Florida Department of Environmental Protection
Division of Environmental Assessment and Restoration
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Tallahassee, Florida 32399

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BASIN MANAGEMENT ACTION PLAN

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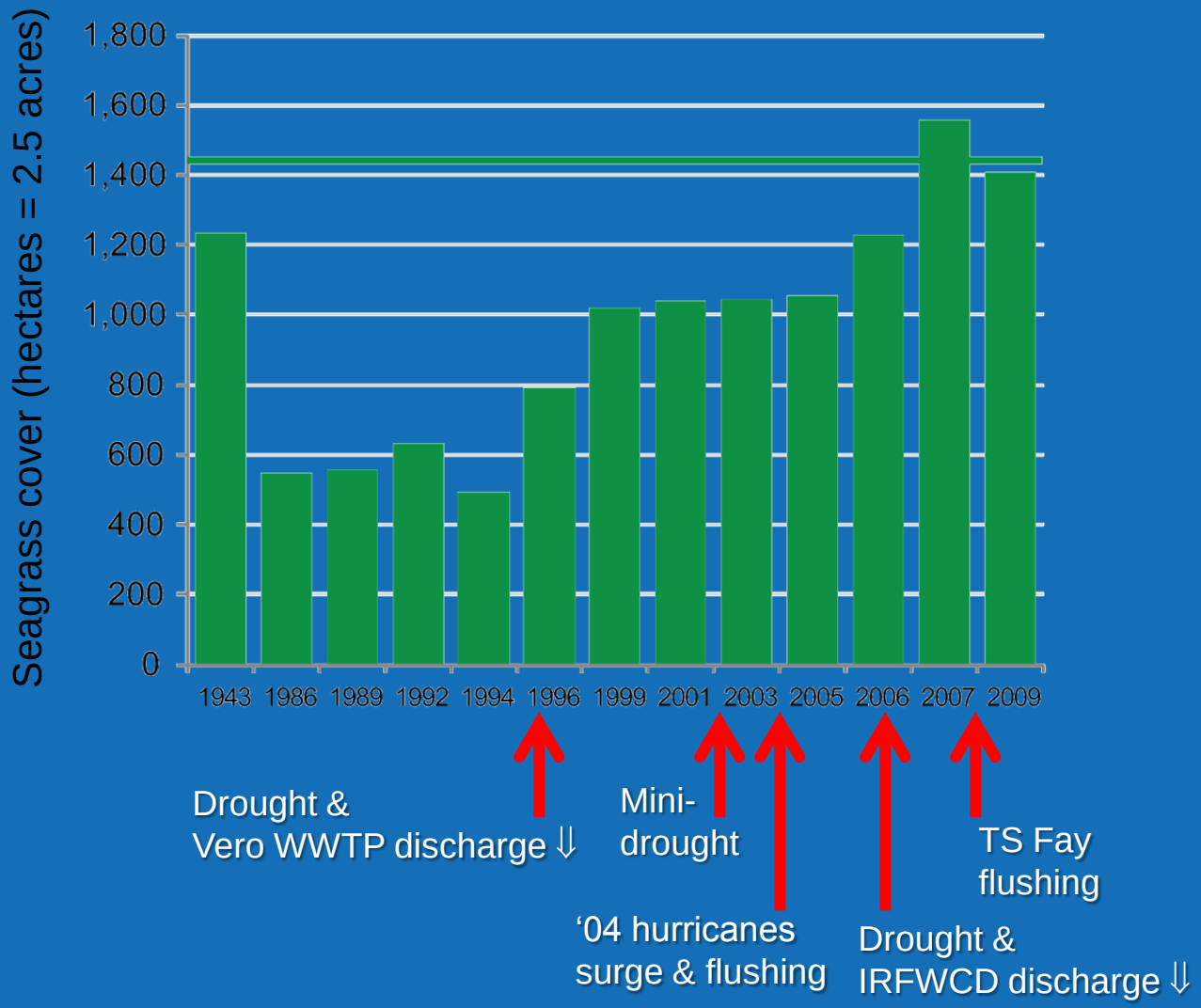
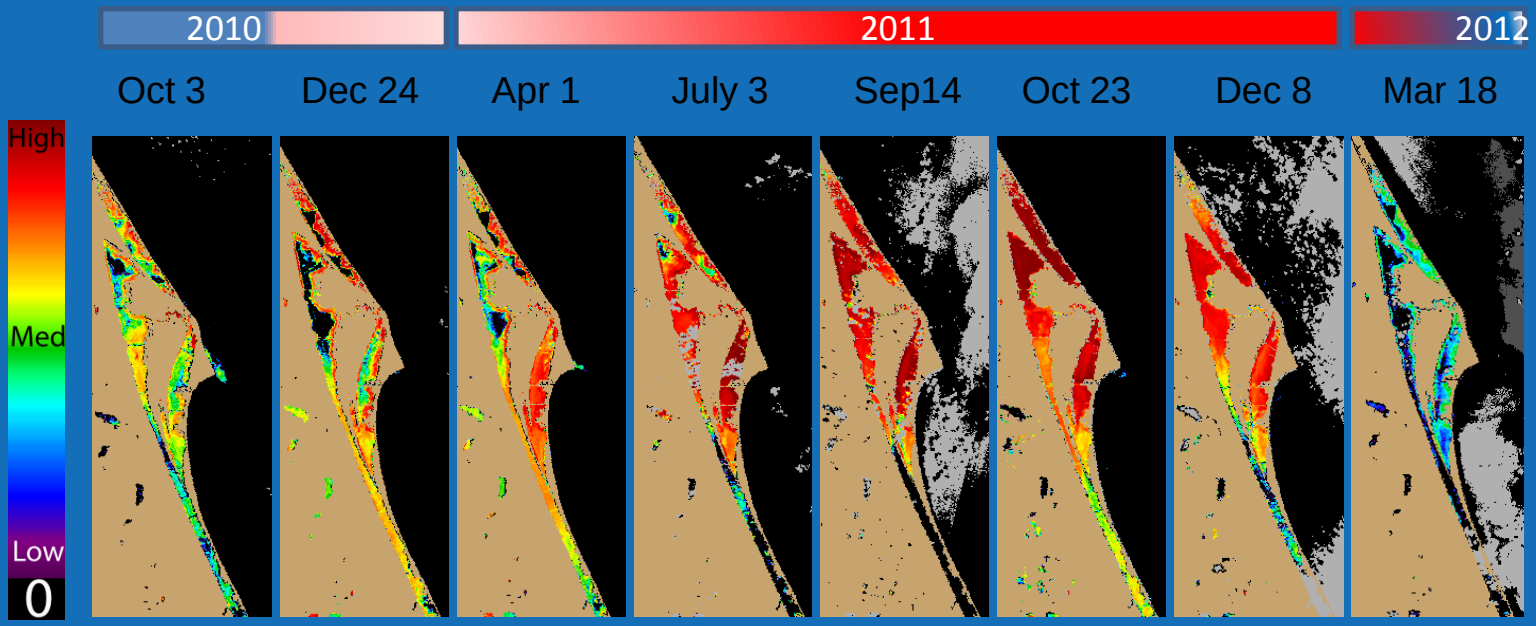
Seagrasses


Seagrass cover (hectares = 2.5 acres)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1943
1986
1989
1992
1994
1996
1999
2001
2003
2005
2006
2007
2009
Drought &
Vero WWTP discharge ⇓
Mini-
drought
'04 hurricanes
surge & flushing
Drought &
IRFWCD discharge ⇓
TS Fay
flushing

Algal blooms

Two phytoplankton (microalgal) blooms



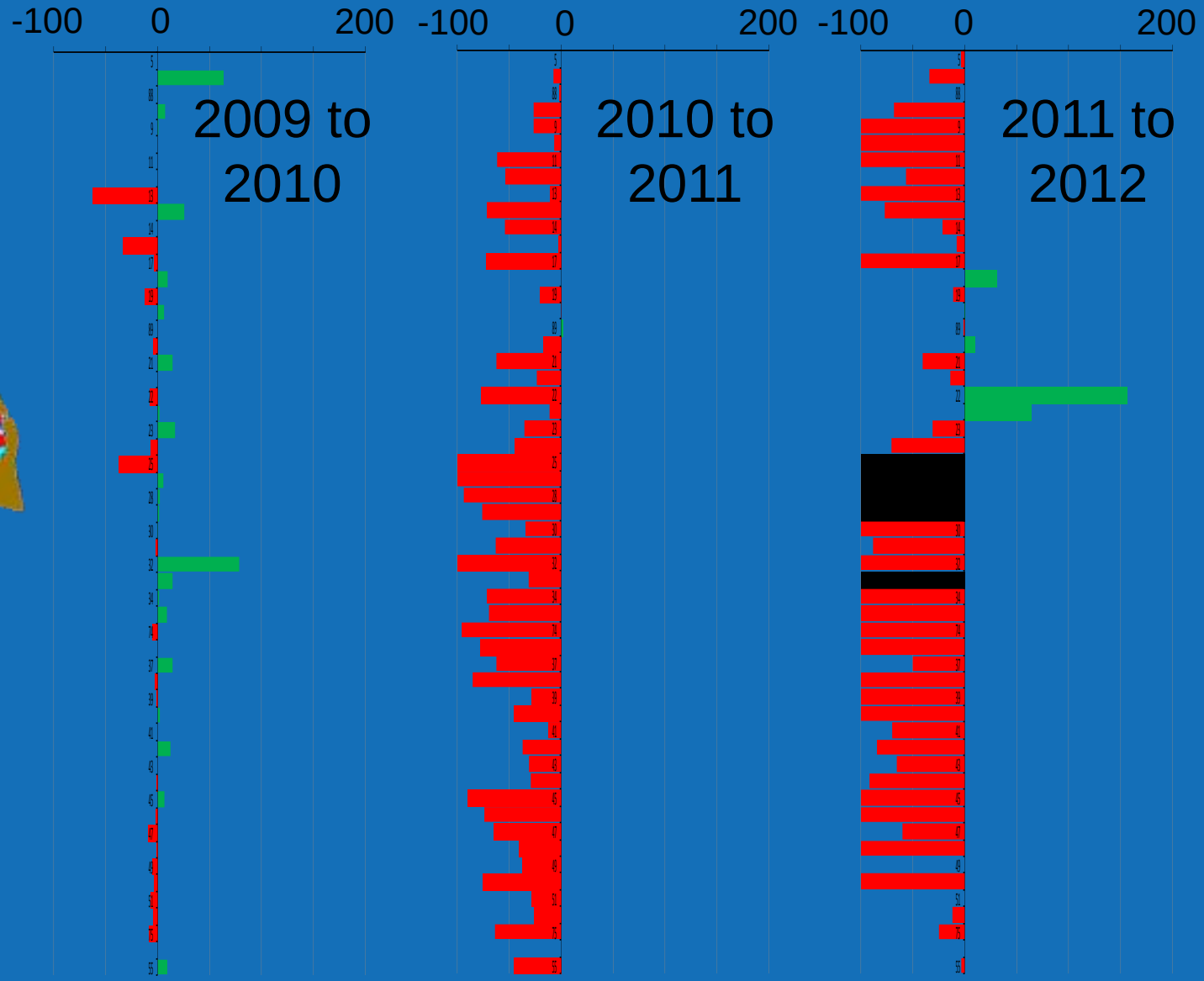
Superbloom in the north –
record magnitude & duration

2 bloom in CIRL –
long duration

Followed in consecutive summers by brown tide

Algal blooms

Percentage gain (green), loss (red) & maintained loss (black)



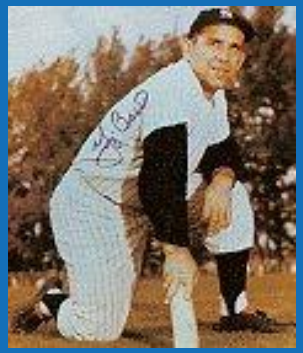
Seagrasses

- Seagrasses shaded
- Seagrasses lost
  - lagoon-wide 30,000–40,000 acres
  - BRL ~21,000 acres
  - NIRL ~5,000 acres
  - CIRL ~6,000 acres

What happened?

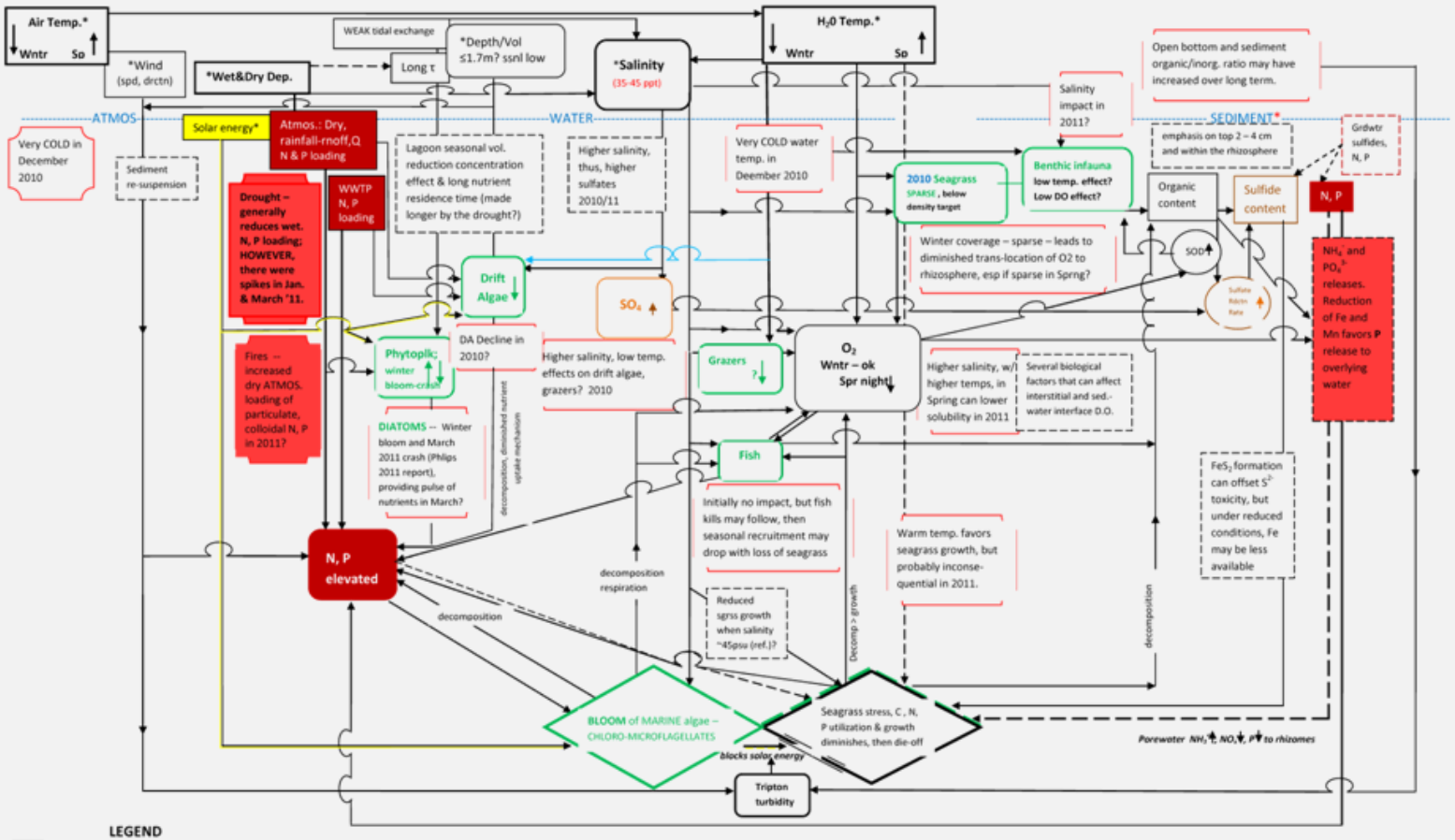
"All models are wrong;
some models are useful."
(attributed to George Box)

"Ecosystems are not only more complex than we think,
they are more complex than we can think."
(Egler, Frank. 1977. *The nature of vegetation: its management and mismanagement*.
Aton Forest Publishers, Norfolk, Connecticut)



"It's tough to make predictions,
especially about the future."
(Yogi Berra)

2011 ALGAL BLOOM & SEAGRASS DIE-OFF
POSSIBLE INTERACTION OF PHYSICAL, CHEMICAL, & BIOLOGICAL FACTORS



Eutrophication progression scheme

Increased nutrient delivery

Binding
Uptake
Cycling
Grazing…

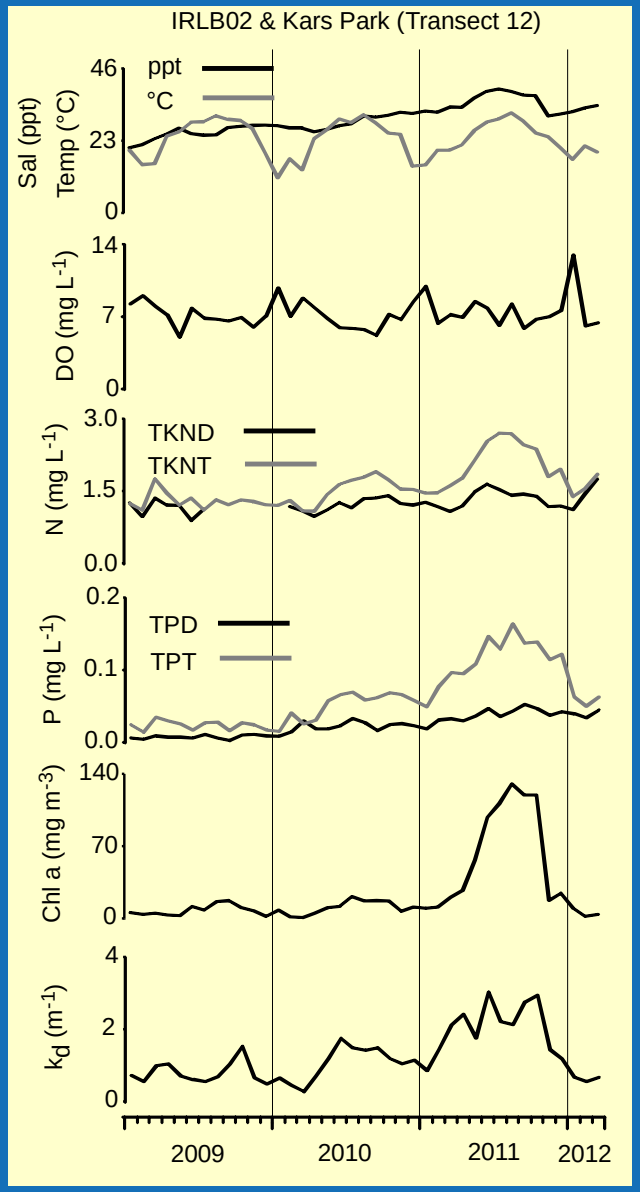
Enhanced growth phytoplankton & macroalgae

Increased shading & benthic respiration

Seagrass loss

Adapted from
C.M. Duarte (1995)

Nutrient loads



Uptake & cycling

Drift Macroalgae

"Tumbleweed" of the Lagoon

Benefits: habitat, nutrient "sponge"

If overabundant, it can be a...

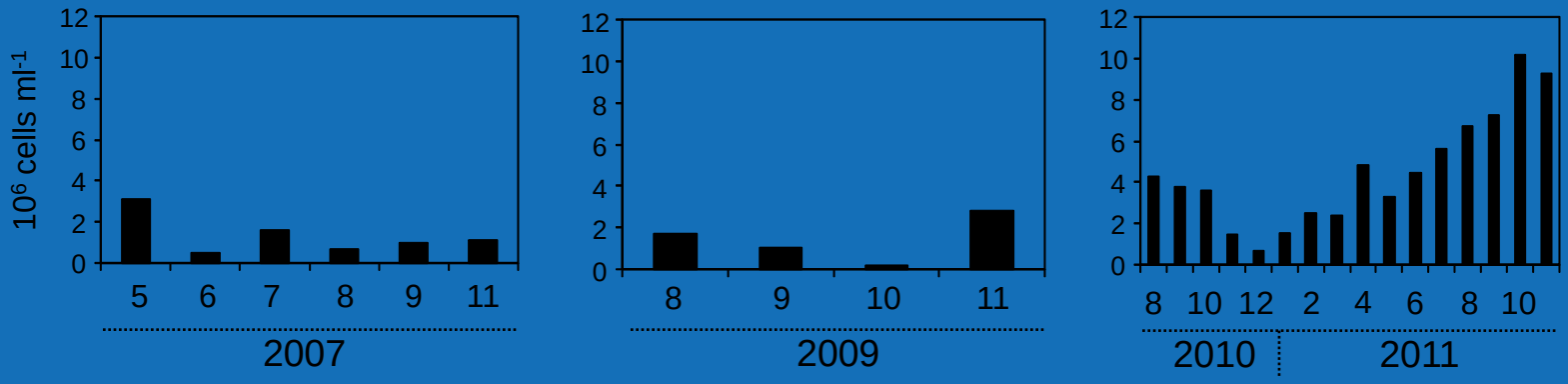
Detriment: outcompete seagrass, be a major source of nutrients

Cycling

Bacterioplankton counts

Not bacterial contamination

Site 3 – Central Banana River

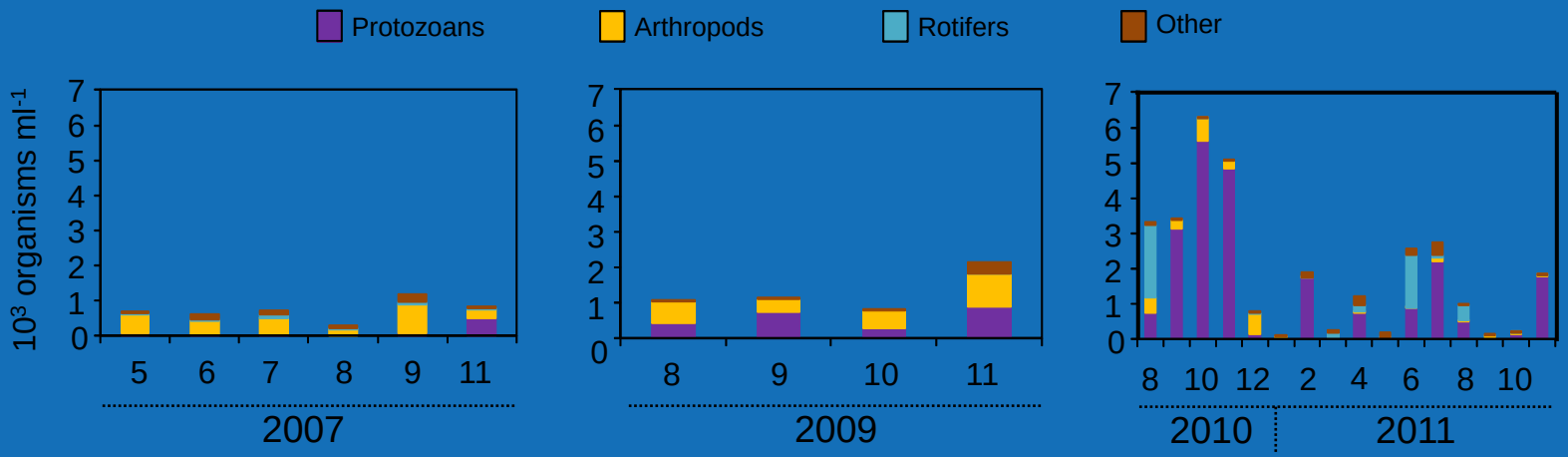


Bacteria cycle nutrients rapidly

Grazing

Zooplankton

Site 3 – Central Banana River



Protozoans & grazing increase

Salinity ⇒ decrease?

Eutrophication progression scheme

Increased nutrient delivery

Binding
Uptake
Cycling
Grazing…

Enhanced growth phytoplankton & macroalgae

Increased shading & benthic respiration

Seagrass loss

Adapted from
C.M. Duarte (1995)

What will we do?

IRL Protection Initiative

- Focus on the IRL
  - internal links among District's functions
  - external links to concerned stakeholders
- Translate new insights into management
  - IRL Algal Blooms Investigation
  - efforts from others & future efforts

IRL Algal Blooms Investigation

- Understand
  - the lagoon's nutrient inventory & cycling
  - processes that regulate blooms
- Evaluate & recommend strategies
  - ameliorate blooms
    - magnitude
    - duration
    - frequency
  - facilitate seagrass growth & expansion

1° scientific resources

District's organizational structure

Blue team:
physical factors, water quality & phytoplankton abundance

ES Estuaries Section; WRI Palm Bay; Engineering

Orange team:
phytoplankton species composition, zooplankton grazers, invertebrate grazers & fish

ES Estuaries Section

Green team:
seagrass, macroalgae & epiphytes

ES Estuaries Section; WRI Palm Bay

Sand team:
sediment biogeochemistry, including effects of infauna

ES Estuaries Section

IRL Scientific Consortium

- Bethune-Cookman U
- FAU/Harbor Branch
- Florida Tech
- Nova Southeastern U
- U of Florida
- Smithsonian Institution
- Fish & Wildlife Conservn Comm
- Seagrass Ecosystems Analysts

Cooperative resourcing

District & IRLNEP (EPA)

State:
FFWCC
FDEP*

Other Federal:
USFWS (CP)
NOAA (CHRP)
USGS

Research grants
via IRL Consortium
(Sea Grant, EPA, NSF, etc.)

* indirectly by supporting core monitoring

Products

- Identification of stresses ⇒ blooms
- Recommendations ⇒ ⇓ stress from "us"
  - revised nutrient loading limits
  - more focus on "legacy loads"
  - new TMDL/BMAP strategies & policies
- Actions ⇒ ⇑ recovery from stresses

Products

- Strategies to control bloom initiation
  - reduce nutrient loads
  - enhance grazers & filter feeders
- Strategies to facilitate seagrass growth
  - seagrass transplanting
  - surgically targeted removal of drift algae
- Strategies to enhance trophic structure
  - diverse
  - multi-leveled

What can I do?

- Understand the issues
- Participate in IRL Protection Initiative
- Join stakeholders & research providers
  - identify knowledge gaps & how to fill them
  - explore funding options

Questions?

IRL BMAP stakeholder research priorities

- Lists in all BMAPs
- Are lists simply a start?
- Go through a prioritizing process?
- Work toward a “business plan”?
  - projects
  - priorities
  - plans for funding

Existing list

- Bathymetry update
- Seagrass transects more & more often
- Phytoplankton & algae surveys
- Loads via inflows & outflows
- BMP effectiveness
- TN, TP & seagrass relationships

Existing list

- Groundwater loads & modeling
- Groundwater [nutrients] & volumes
- Storm event samples
- Staging & retained runoff ⇒ loads ⇓
- Sediment nutrient flux & recycling
- Wakes ⇒ turbidity ⇒ Δ seagrass

Existing list

- Bathymetry update
  - spatial gaps – N Mosquito, dredging
  - broad-scale survey = ?
  - funds needed

Existing list

- Seagrass transects more & more often
  - summer & winter at all transects
  - additional monthly transects (6 + 14 = 20), especially in superbloom region

Existing list

- Phytoplankton & algae surveys
  - phytoplankton monitored
  - drift macroalgae surveys alternate w/ seagrass mapping
  - attached macroalgae = comment

Existing list

- Loads via inflows & outflows
  - targeted efforts in superbloom region
    - canals at Gus Hipp Blvd, Rockledge
    - outfall Bracco Ponds STA, Cocoa
    - Turnbull Creek at US 1

Existing list

- BMP effectiveness
  - would synthesizing past studies help
  - further work belongs to stakeholders

Existing list

- TN, TP & seagrass relationships
  - better data on sources from IRL-ABI
  - updated modeling from IRL-ABI

Existing list

- Ground water loads & modeling
  - some work for BRL & NIRL from IRL-ABI
  - others – Air Force
- Ground water [nutrients] & volumes
  - further work belongs to stakeholders

Existing list

- Storm event samples
  - targeted efforts in superbloom region
    - canals at Gus Hipp Blvd, Rockledge
    - outfall Bracco Ponds STA, Cocoa
    - Turnbull Creek at US 1

Existing list

- Staging & retained runoff ⇒ loads ⇓
  - District gather data at some projects
  - work at others belongs to stakeholders

Existing list

- Sediment nutrient flux & recycling
  - IRL-ABI work in superbloom region

Existing list

- Wakes ⇒ turbidity ⇒ Δ seagrass
  - work belongs to stakeholders

IRL BMAP stakeholder research priorities

- Lists in all BMAPs
- Are lists simply a start?
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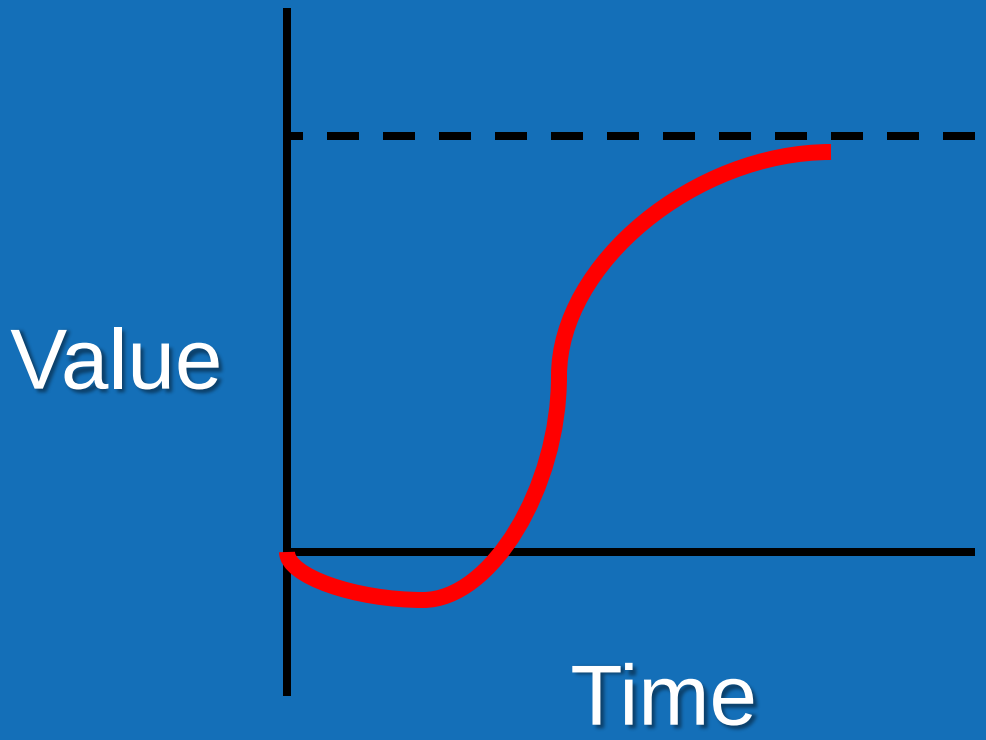
Attractiveness & Feasibility

- Attractiveness
  - potential benefit
    - answer key Q
    - impact critical risk
    - deliver “flow-ons”
  - ability to capture
    - users
    - uses
    - precursors
    - acceptability
- Feasibility
  - potential for success
    - S-curve*
    - excitement
    - pace
  - capacity for success
    - resource needs
    - resource availability
    - others get there 1st

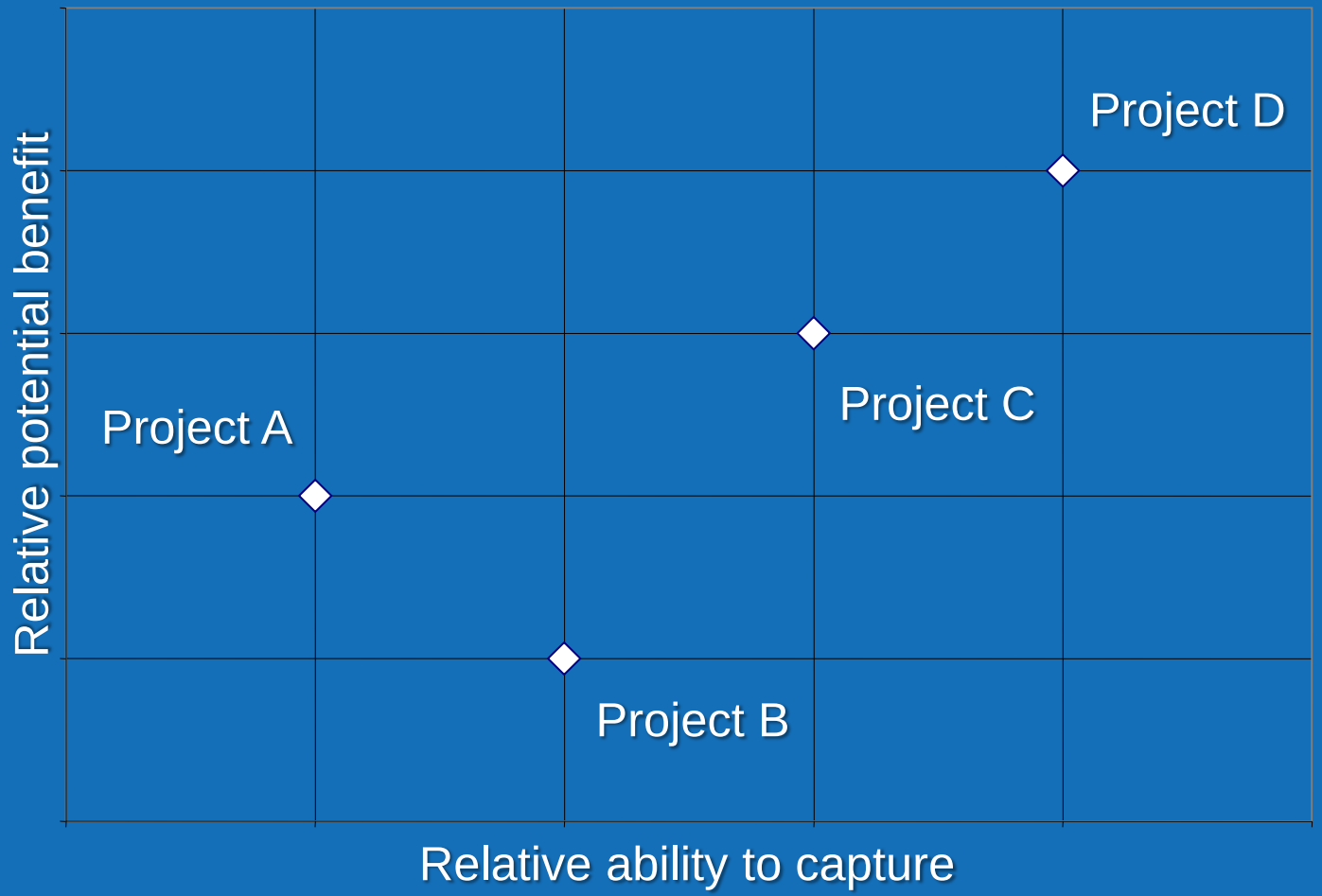
S-curve



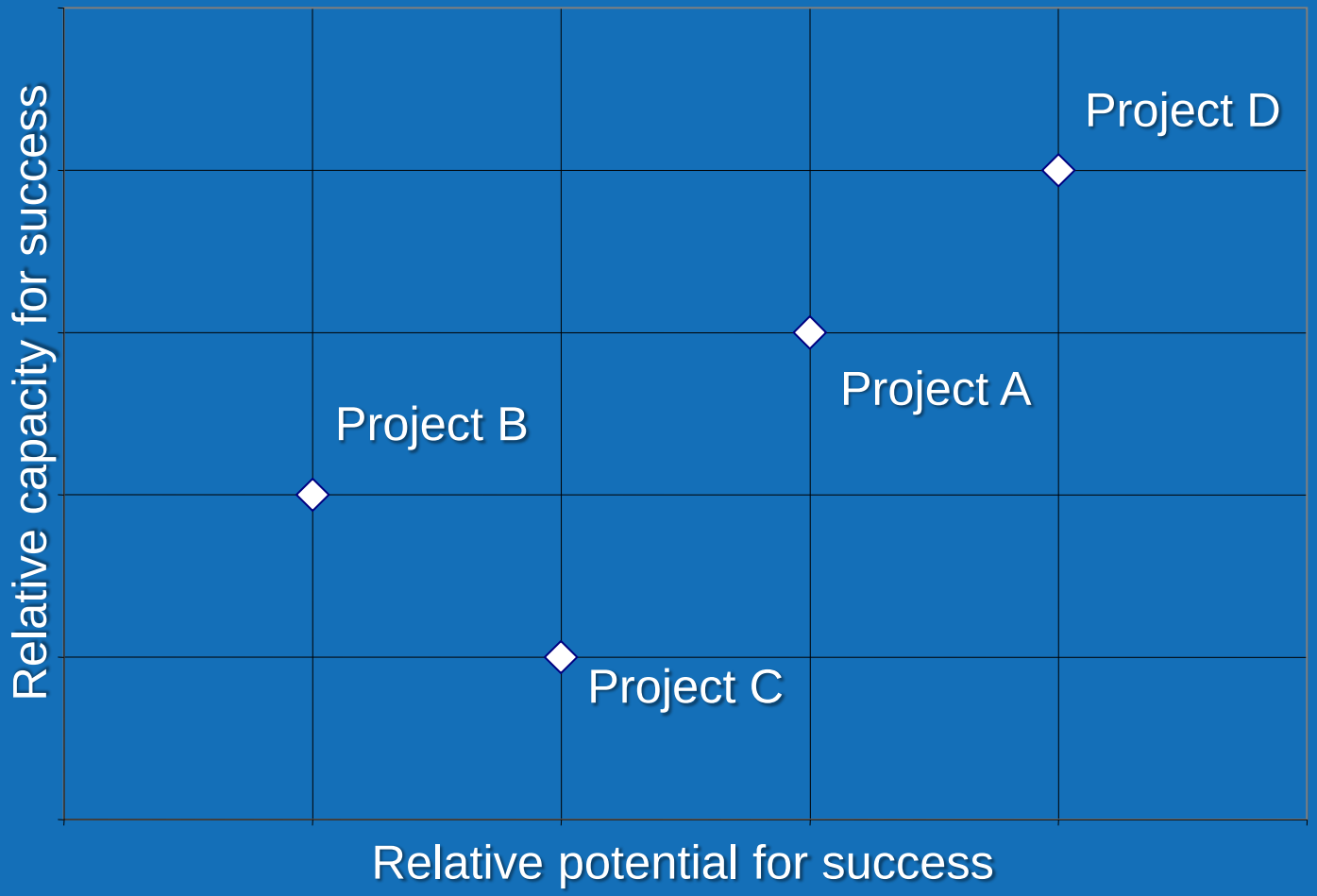
Attractiveness & Feasibility

Project	Potential benefit (1)	Ability to capture (2)	Potential for success (3)	Capacity for success (4)	Attractiveness (1x2)/ (# projects)	Feasibility (3x4)/ (# projects)
A	1	2	3	3	2/4	9/4
B	2	1	1	2	2/4	2/4
C	3	3	2	1	9/4	2/4
D	4	4	4	4	16/4	16/4

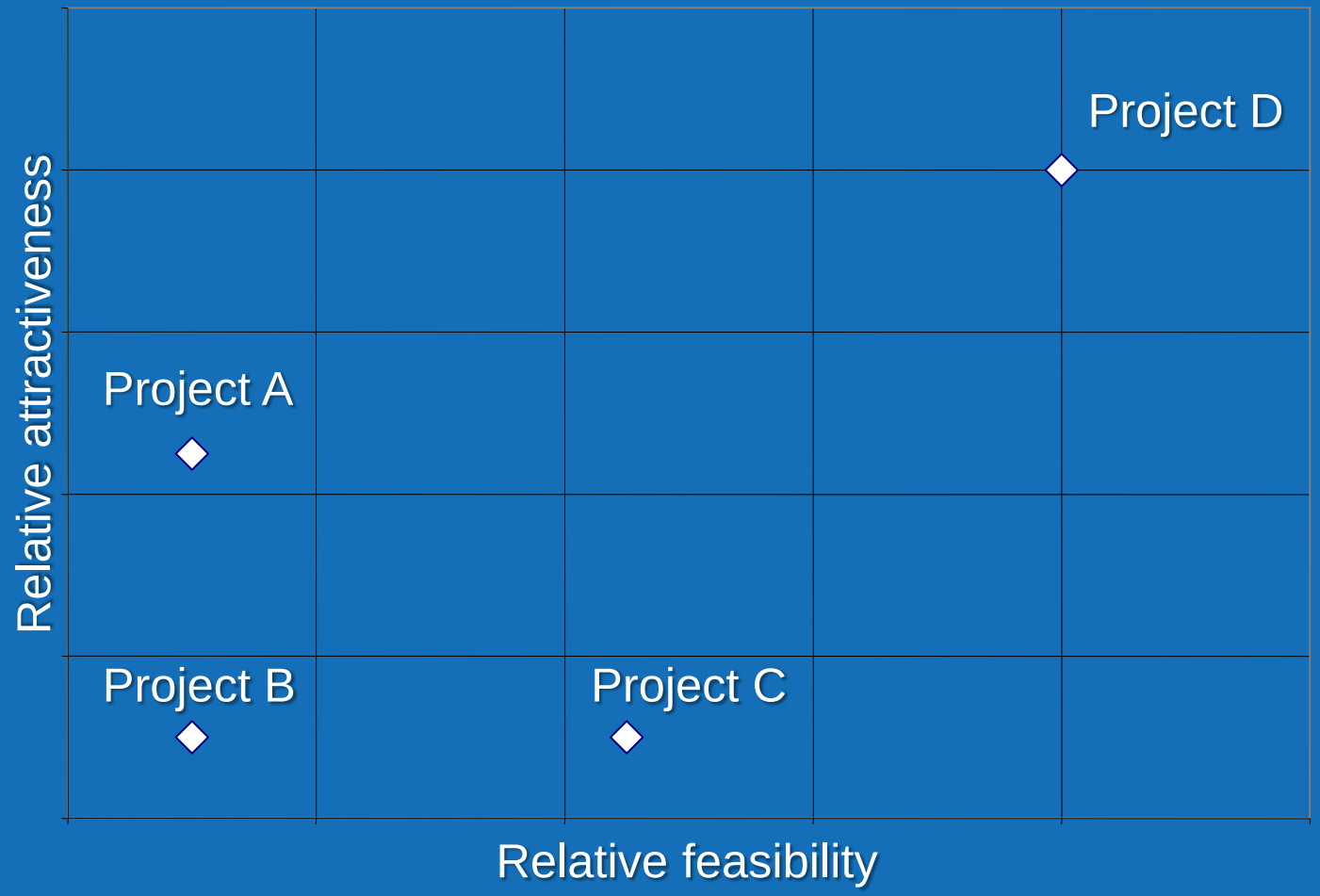
Attractiveness



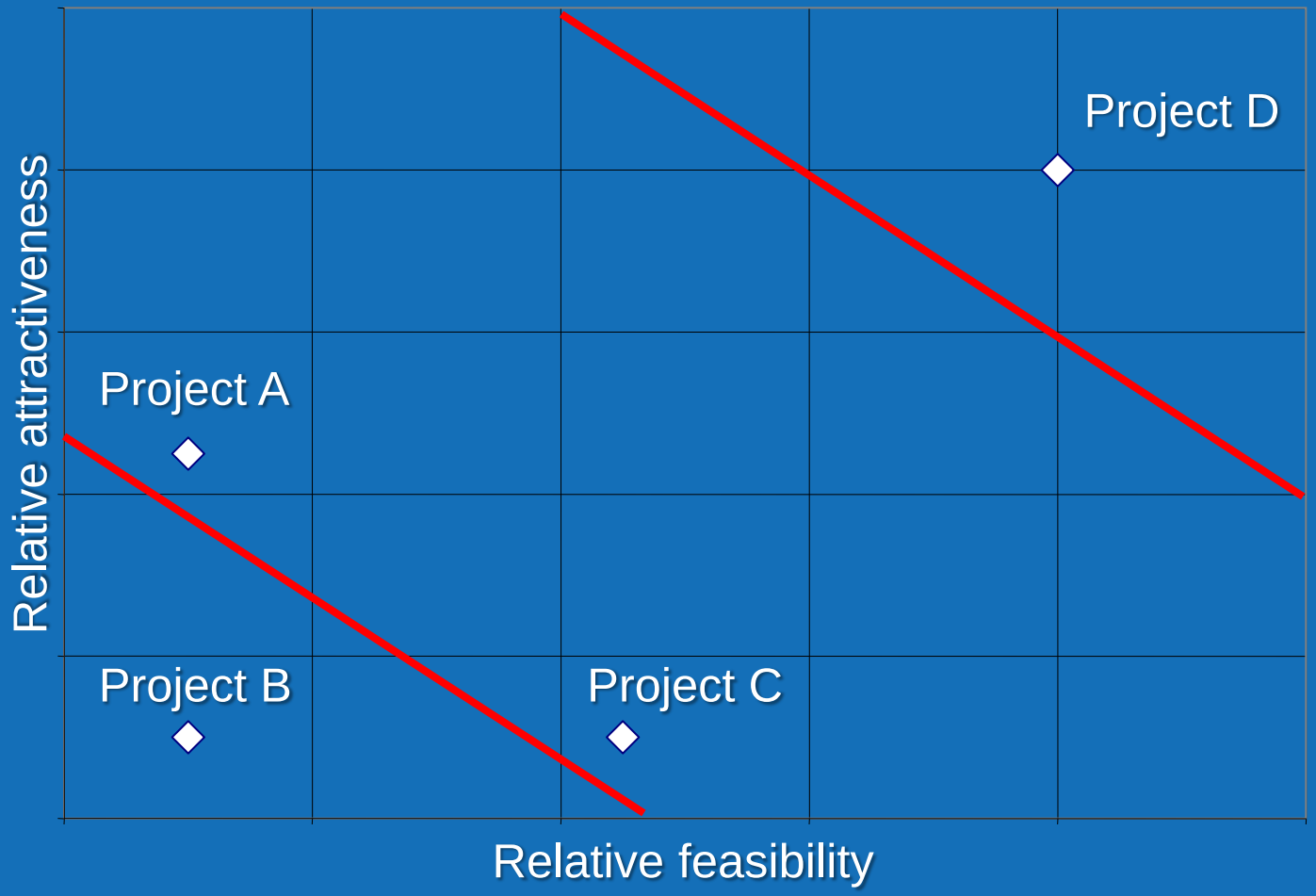
Attractiveness



Attractiveness × Feasibility



Attractiveness × Feasibility



Questions?

FY15/16 ~$1.3M + operational budget*

End contractual data collection in 4th quarter; additional 3 quarters for data synthesis & final report

FY14/15 ~$1.7M + operational budget*

Continue contracts let in previous FYs

FY13/14 ~$1.8M + operational budget*

- SAV nutrient content & release rates **CONTRACT $150K/y in 1st y $75K in 2nd y**
- On-site consultants (3) biogeochemist data manager GIS specialist **CONTRACT $386K/y for 3 y**
- Peer review (plans, reports, unsolicited proposals) **CONTRACT $40K/y for 3 y**
- Epifauna surveys **CONTRACT $75K in 1st y $150K/y after**
- Sediment surveys **CONTRACT $70K/y for 2 y**
- Drift algae survey feasibility study **CONTRACT $25K in 1st y $10K 2nd y**
- Wind, salinity, temperature & inlet water level **CONTRACT $60K/y after**
- Upgrade plankton monitoring (phytoplankton & zooplankton) **CONTRACT $100K/y for 3 y**
- Infauna surveys **CONTRACT $75K in 1st y $150K/y after**
- Groundwater model **CONTRACT $80K for 1st y $100K/y for 2nd y $50K for 3rd y**
- Drift algae tolerance (temperature, salinity, light) **CONTRACT $94K in 1st y $100K 2nd y**
- Hydrodynamic model code **CONTRACT $100K for 1 y only**
- Nutritional requirements of phytoplankton **CONTRACT $75K/y for 3 y**
- Grazer effects on bloom **CONTRACT $50K for 1st 6 mos $75K/y for 2 y**
- Internal nutrient budget **CONTRACT $110K for 1st y ≤ $150K/y for 2 y**

FY12/13

- Seagrass transplant (recovery) experiment **CONTRACT ~$25K/y for 2-3 y**
- Field calibration for stage/flow/WQ model & nutrient loading estimates **CONTRACT $80K in 1st y $200K/y after**
- Atmospheric deposition (CASTnet) **CONTRACT $20K 1st y $34K/y after**
- Expand FFWCC fisheries monitoring into Mosquito Lagoon **CONTRACT $40K for 1st 6 mos $79K/y after**

* Annual operational budget = ~$500,000 for core monitoring