Package Evaluation by the Delay-Difference Model

Christopher Costello
Carl Walters
Ray Hilborn

January 23, 2008
MLPA SAT, Pacifica CA

1

Outline of package evaluation

1. Preliminary comments
2. Methods
   - "Base Case" parameter values
   - Method for partial sensitivity analysis
3. Results
   - Base case spatial results
   - Base case region-wide results
   - Sensitivity analysis results
   - Invertebrate results
4. General insights

2

Preliminary Comments

- EDOM has the following features:
  - Equilibrium spatial biological model with adult and larval movement
  - Fishing fleet (uniform effort, opportunistic fishermen, economically optimized mgt.)
  - Multiple species
- Outputs
  - Spatial distribution of biomass, harvest, profit, sport effort by species
- Dynamical models extend and refine models that generated size/spacing guidelines.

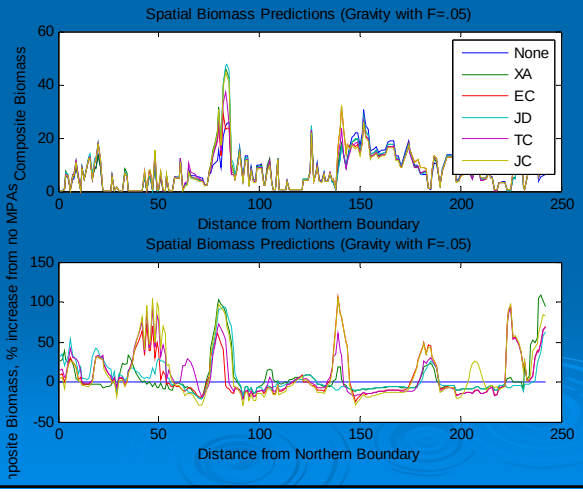
3

Base Case Parameterization

- Base Case
  - 5 species (Lingcod, Cabezon, Black Rockfish, Canary Rockfish, California Halibut)
    - Home range radius (.5 km - 10 km)
    - S.D. Gaussian larval dispersal (10 km – 45 km)
  - Fishing effort outside reserves
    - "Good Management" (fleet model with F=.05)
    - "Poor Management" (fleet model with F=.10)
    - "Management Fails" (fleet model with F=.15)
    - "Optimized for Profit" (spatial optimization)

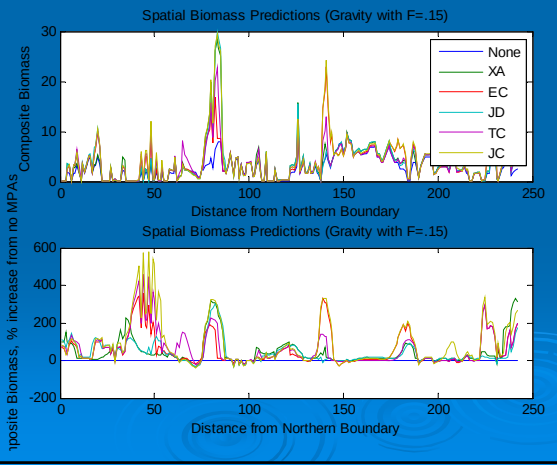
4

Spatial Biomass (F=.05)



5

Spatial Biomass (F=.15)



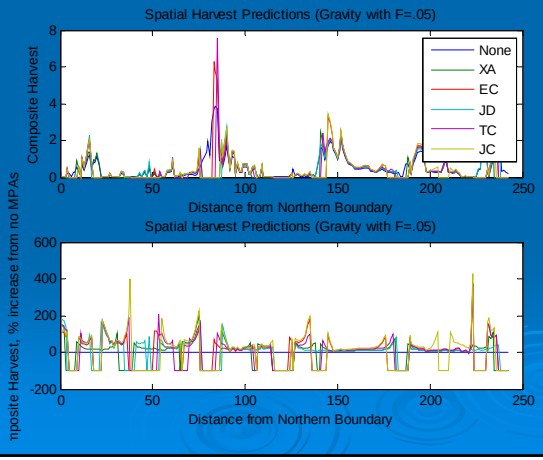
6

Summary of spatial biomass

- Under "Good Management":
  - All packages tend to increase biomass, but some areas of decreased biomass.
  - Effects range from -20% to 110%
- Under "Management Fails":
  - All packages significantly increase biomass nearly everywhere.
  - Effects range from -25% to 600%

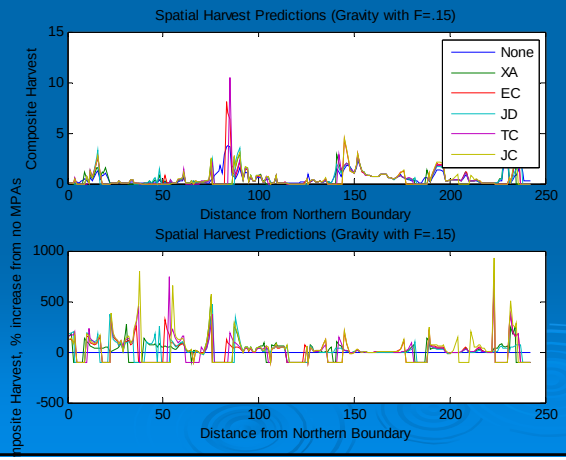
7

Spatial Harvest (F=.05)



8

Spatial Harvest (F=.15)



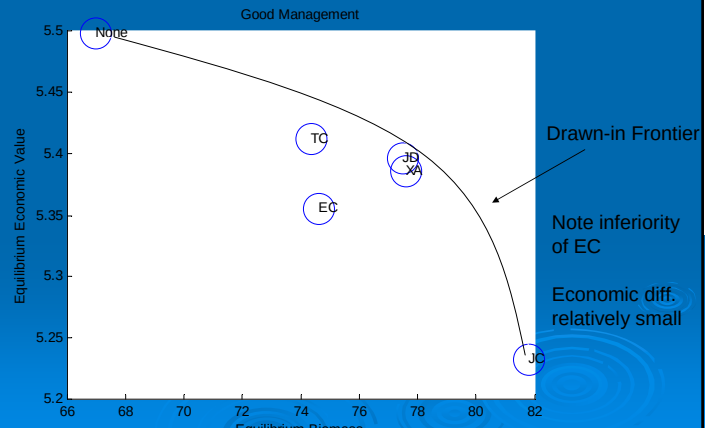
9

Summary of spatial harvest

- Under "Good Management":
  - Equilibrium harvest increases in some areas (spillover) and decreases in others (reserve)
  - Harvest increases in: 63% of patches (JC) to 75% of patches (XA and JD), decreases in complement.
- Under "Management Fails":
  - Harvest can be significantly higher in certain open locations
  - Harvest increases in: 54% of patches (JD) to 59% of patches (XA), decreases in complement.

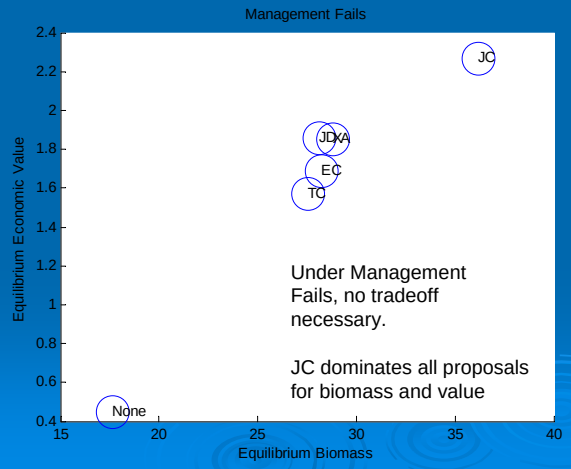
10

Biomass vs. Economics (F=.05)



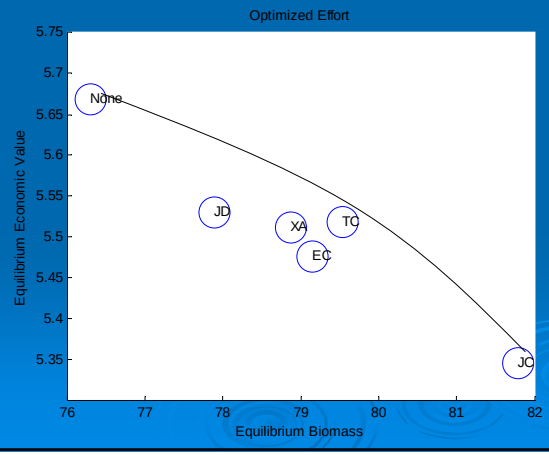
11

Biomass vs. Economics (F=.15)



12

Biomass vs. Economics (Optimized for Economic Profit)



More-or-less Linear tradeoff

Relatively small diff. in value and biomass

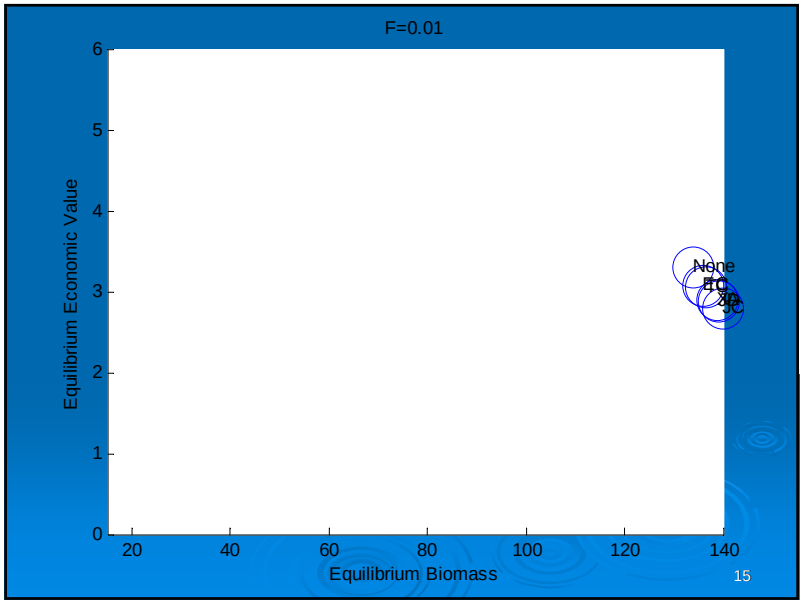
TC and JC tend to dominate

13

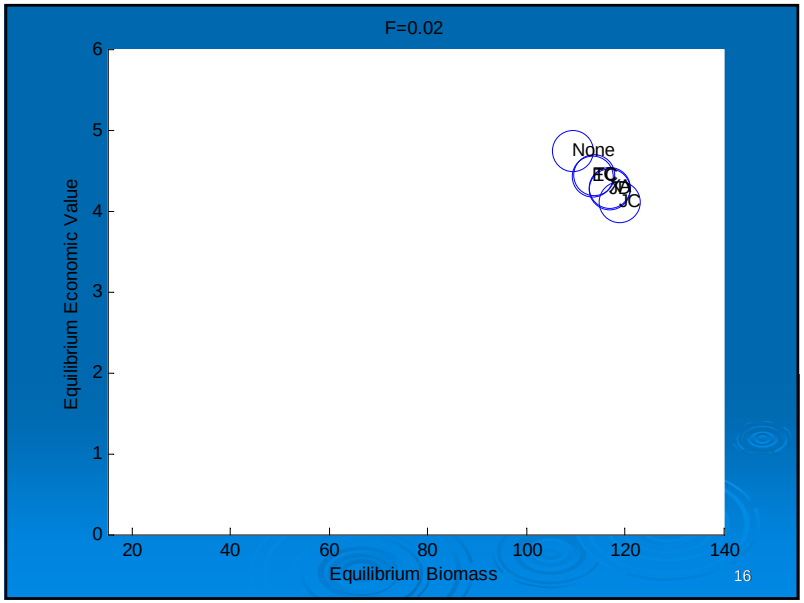
How bad does management have to be?

- For good management, all packages will impose an economic cost, and will increase fish biomass.
- For severely failed management all packages will increase biomass and economic value
- How bad does management have to be to achieve this win-win?

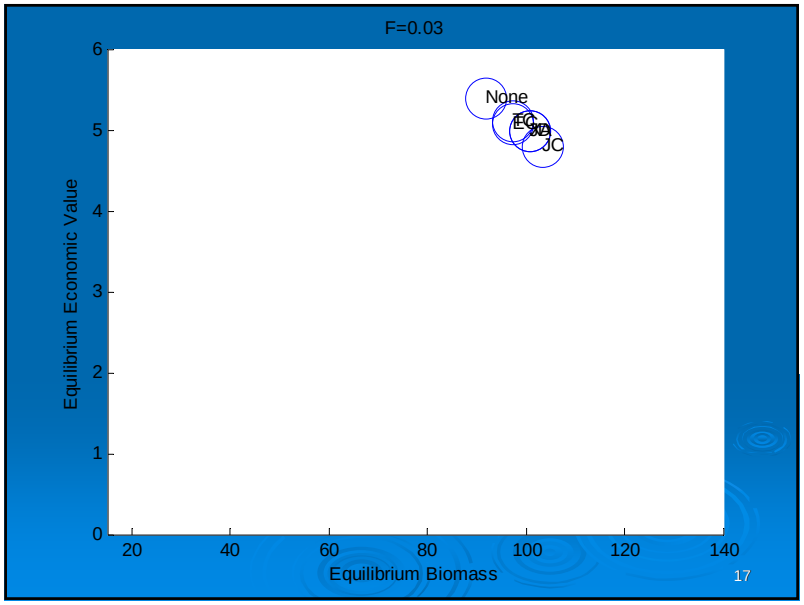
14

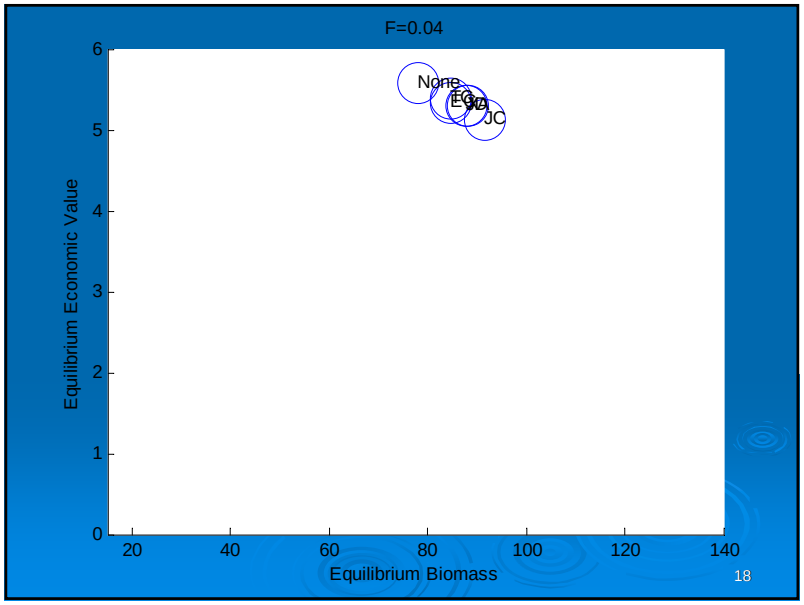


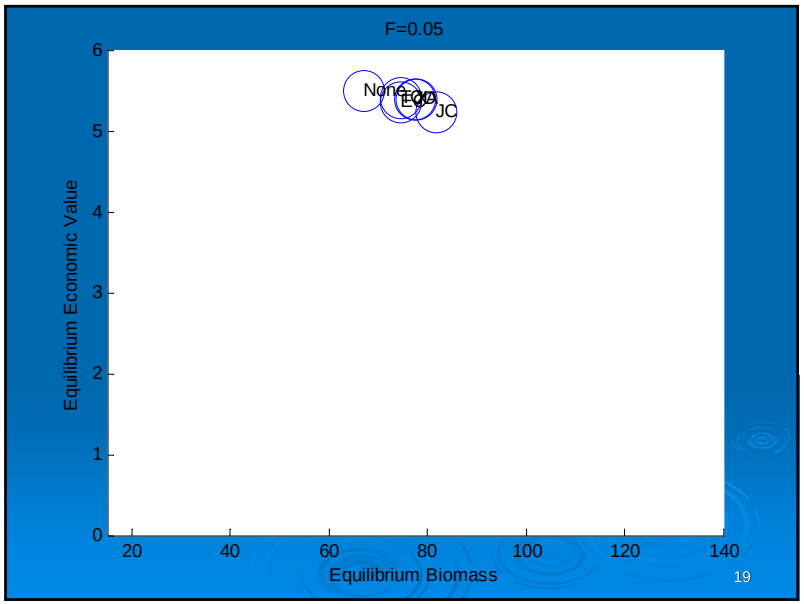
15

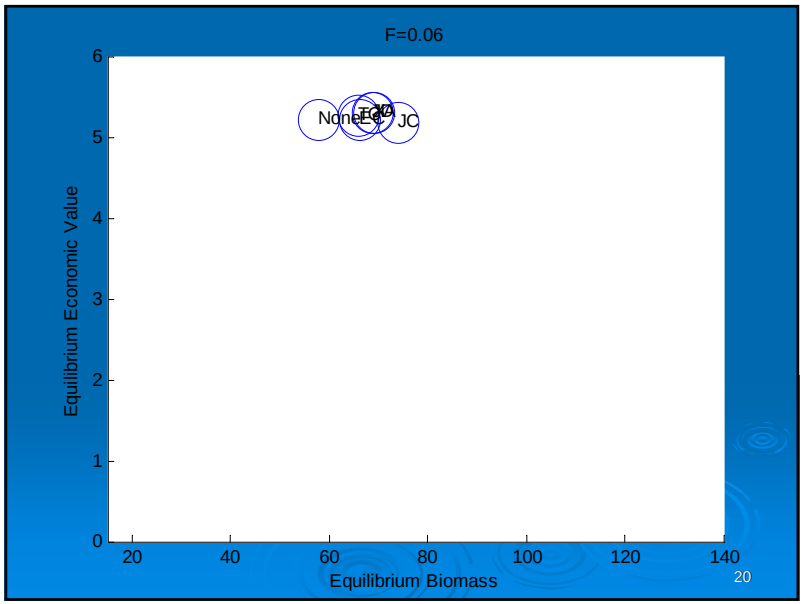


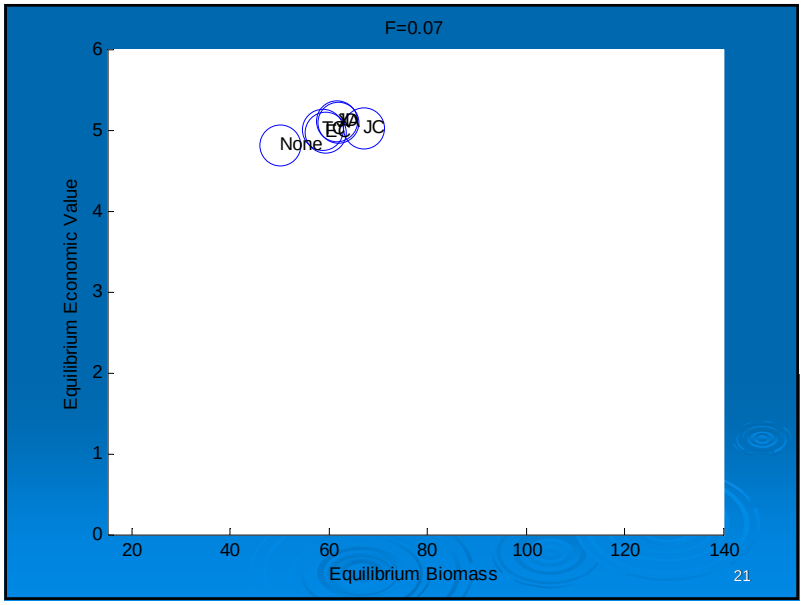
16

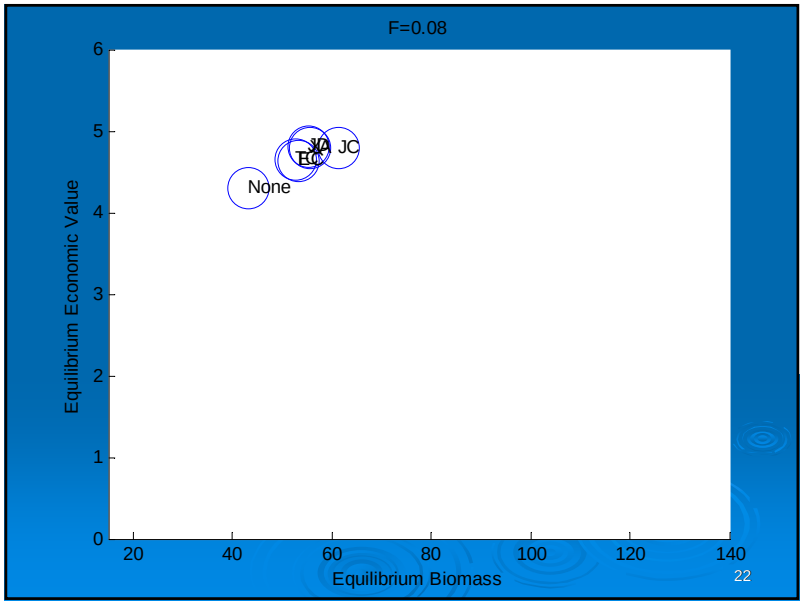

F=0.03
Equilibrium Economic Value
Equilibrium Biomass
None
JC
17

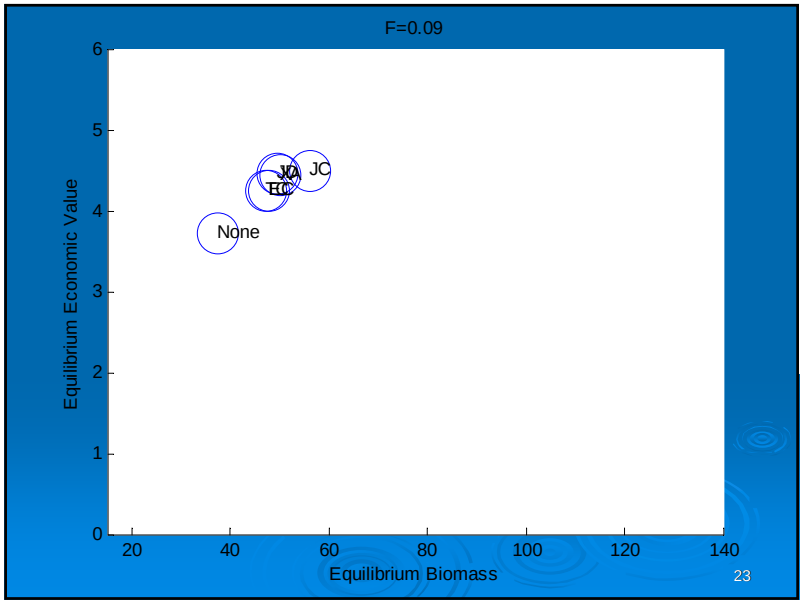

F=0.04
Equilibrium Economic Value
Equilibrium Biomass
None
JC
18

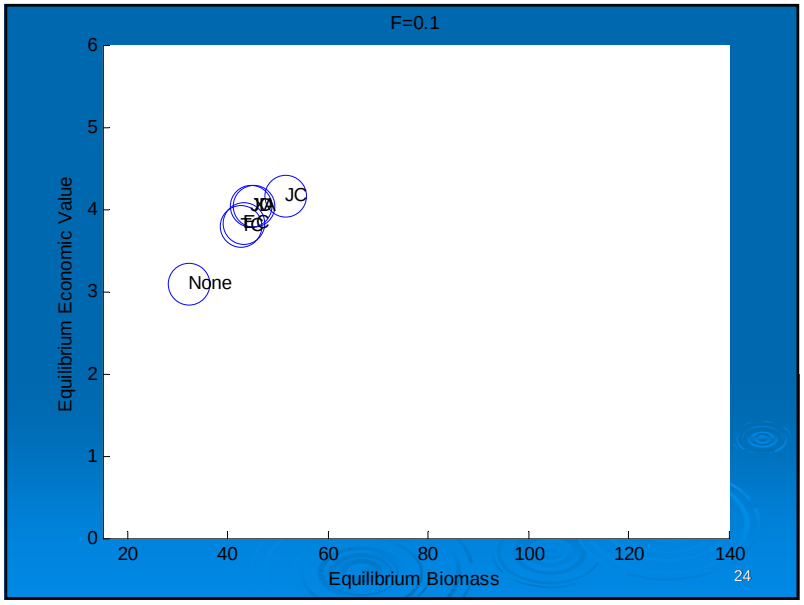

F=0.05
Equilibrium Economic Value
Equilibrium Biomass
None
JC
19

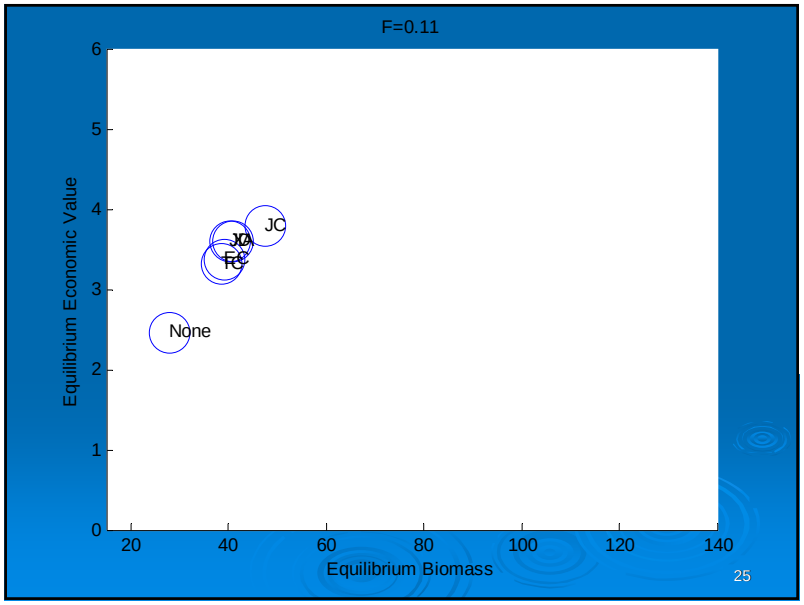

F=0.06
Equilibrium Economic Value
Equilibrium Biomass
None
JC
20

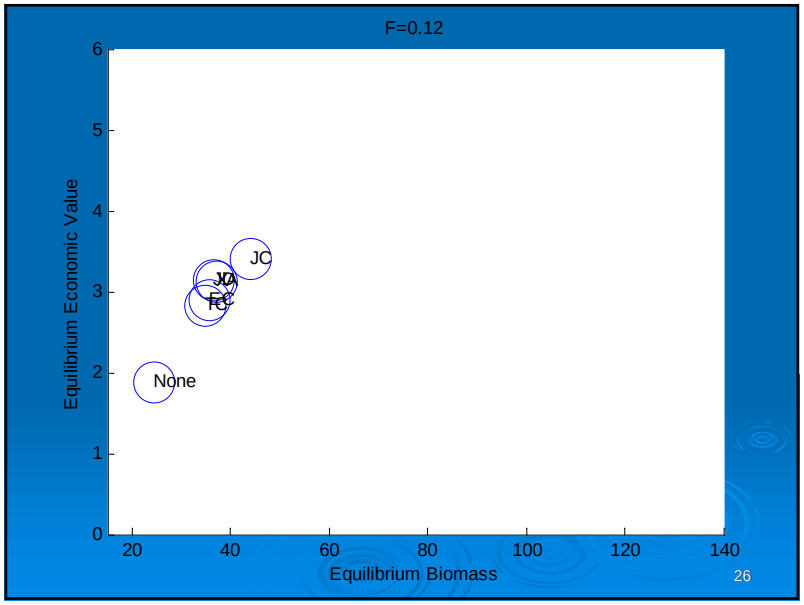

F=0.07
Equilibrium Economic Value
Equilibrium Biomass
None
JC
21

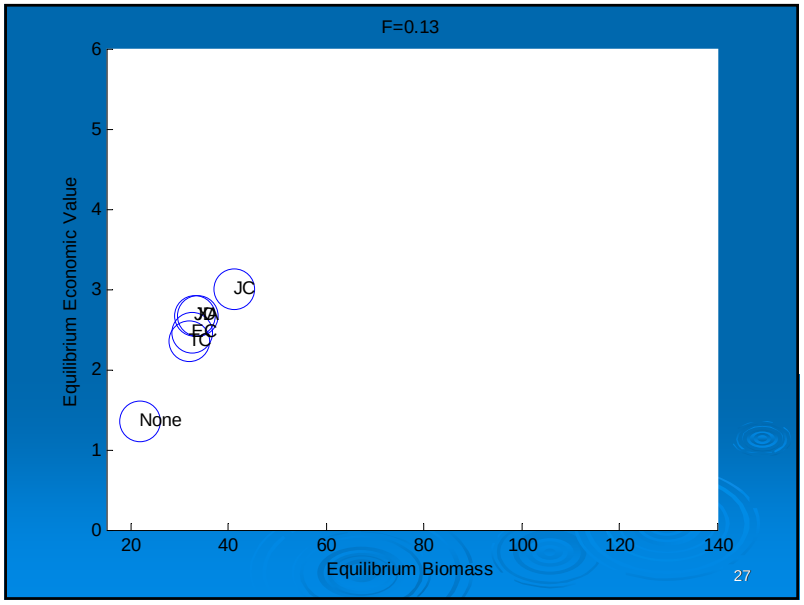

F=0.08
Equilibrium Economic Value
Equilibrium Biomass
None
JC
22

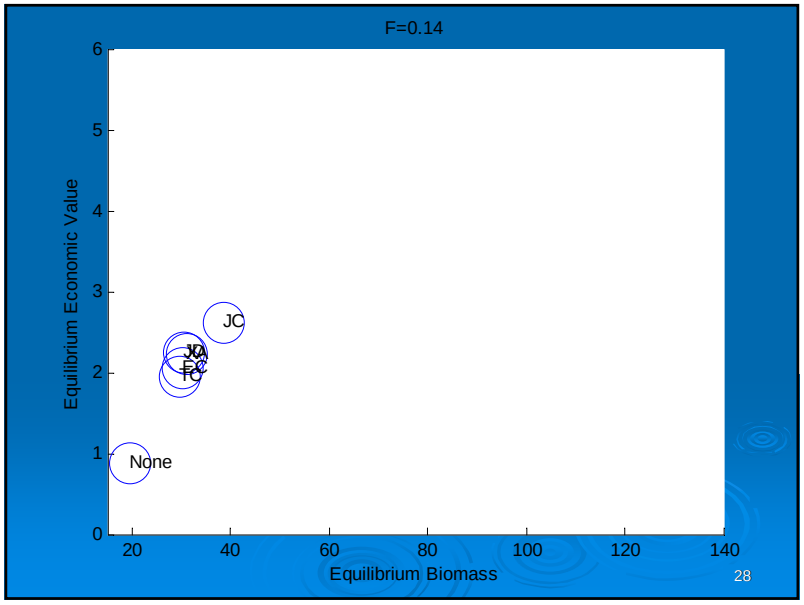

F=0.09
Equilibrium Economic Value
Equilibrium Biomass
None
JC
23

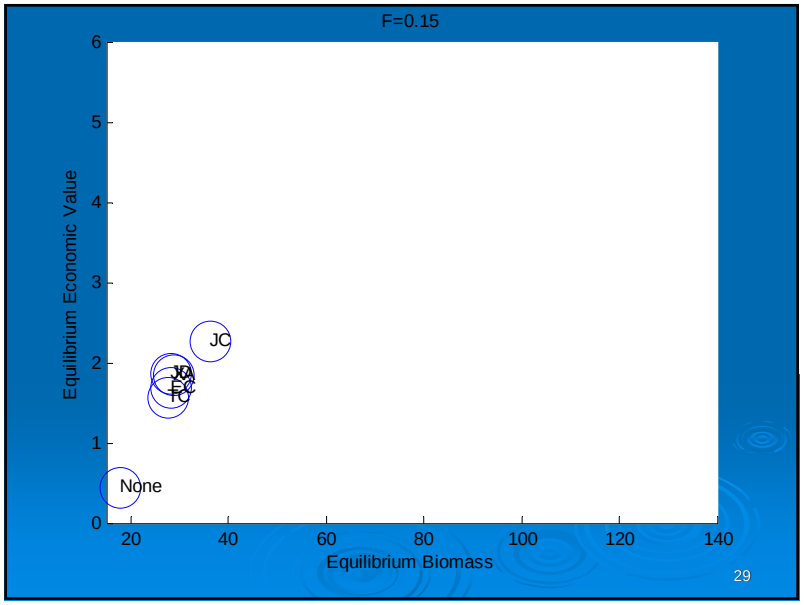

F=0.1
Equilibrium Economic Value
Equilibrium Biomass
None
JC
24


F=0.11
Equilibrium Economic Value
Equilibrium Biomass
JC
None
25


F=0.12
Equilibrium Economic Value
Equilibrium Biomass
JC
None
26


F=0.13
Equilibrium Economic Value
Equilibrium Biomass
JC
None
27


F=0.14
Equilibrium Economic Value
Equilibrium Biomass
JC
None
28



29

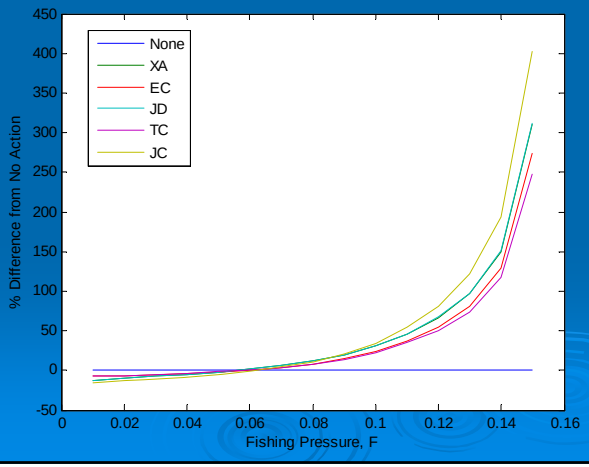
How bad does management have to be?

- If F>0.06, all packages are win-win from economic and biological point of view
- JC always dominate biological outcome
- For pretty bad management (.06-.08) JD and XA dominate economics
- For management fails JC dominates both

- The more overfished you think the fishery will be in the future, the more you should like JC (goes for fishermen and conservationists)

30

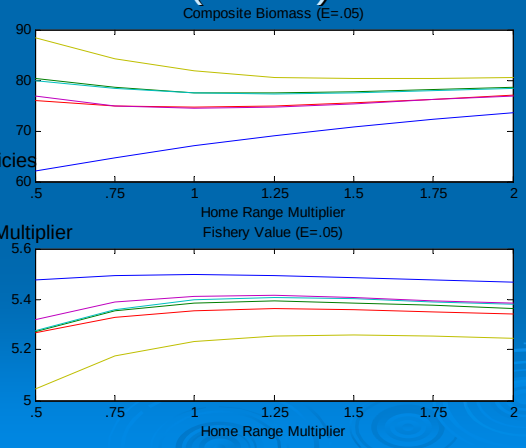
Economic Profit vs. Fishing Pressure



31

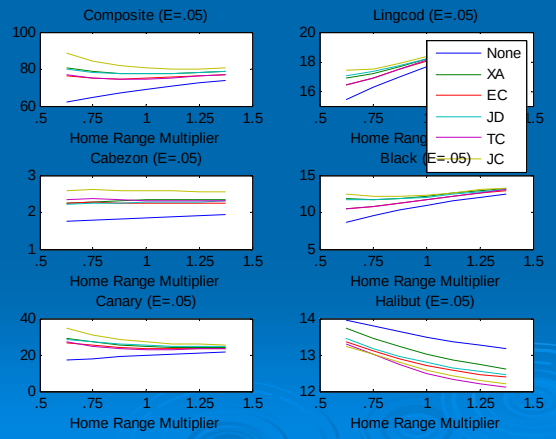
Sensitivity Analysis: Home Range (F=.05)

Ranking of policies for biomass is insensitive to Home Range Multiplier



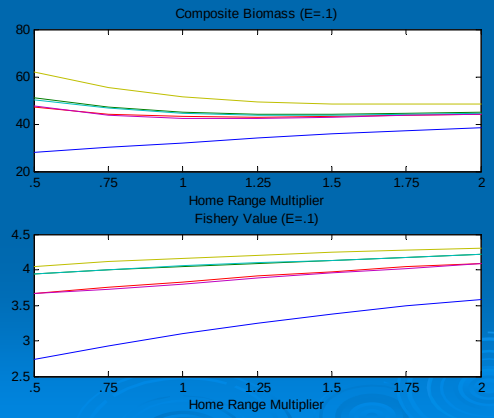
32

Home Range (species-by-species)



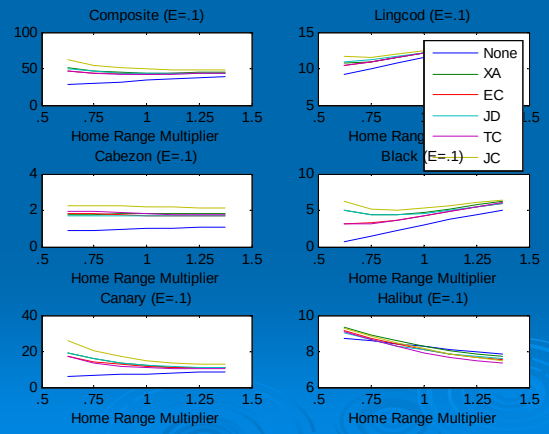
33

Sensitivity to Home Range (F=.1)



34

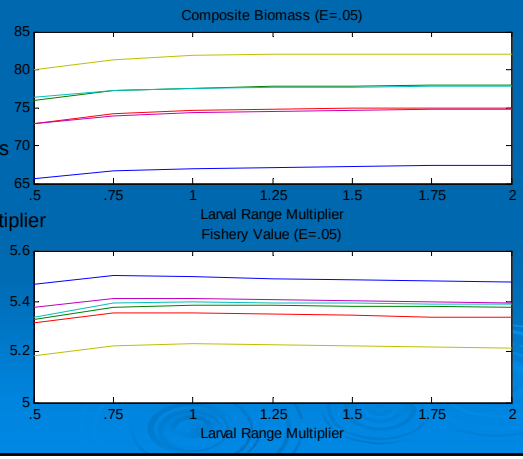
Home Range (species-by-species)



35

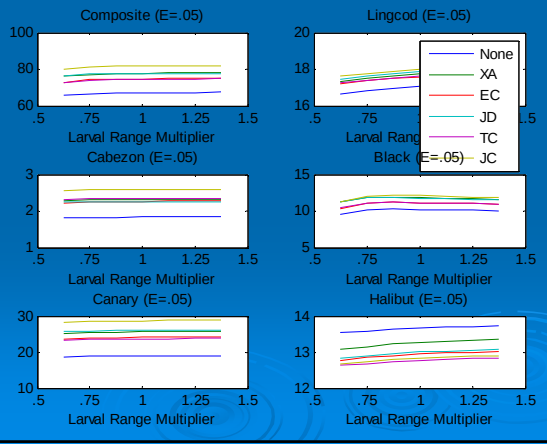
Sensitivity to Larval Dispersal Distance (F=.05)

Ranking of policies for biomass is insensitive to Larval Range Multiplier



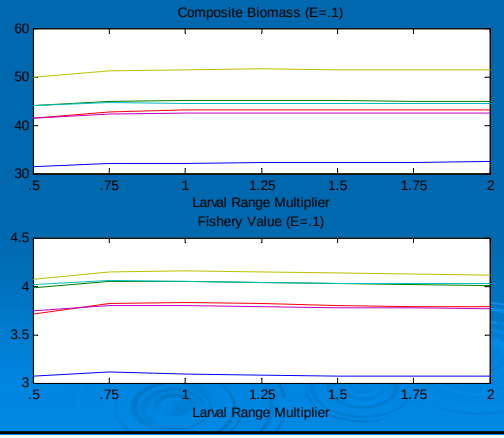
36

Larval, species-by-species



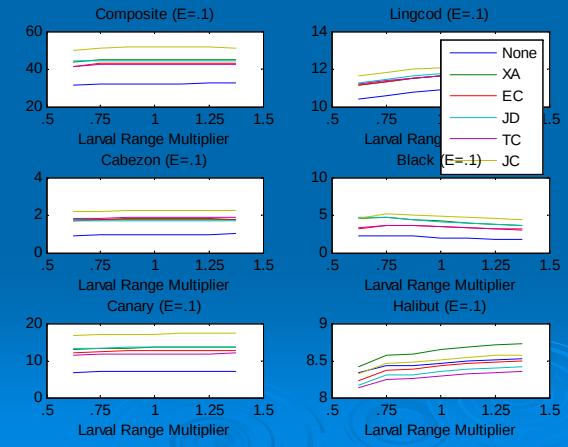
37

Sensitivity to Larval Dispersal (F=.1)



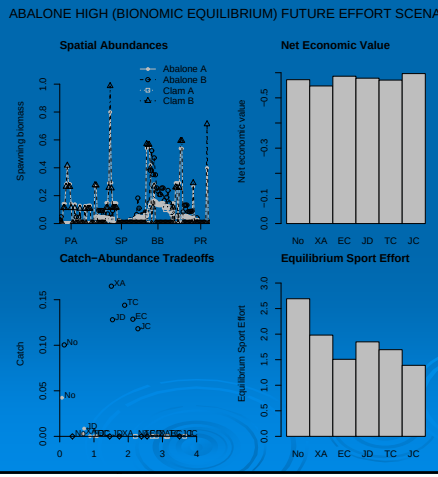
38

Larval, species-by-species



39

Invertebrates – Management Fails



Short dispersers may not increase economic value due to no spillover

Reserves increase biomass for short and long dispersers

40

General Conclusions

- If overall abundance is the objective, JC dominates under all fisheries scenarios.
- MPAs may reduce biomass of sandy-bottom species in a multi-species fishery.
- Spatial biomass can decrease in some areas, may increase by 6-fold with MPAs (under mgt. fails)
- Economic losses turn to gains for F>.06
  - Severely underfished: losses of up to 20% (JC most harm, but little difference)
  - Well managed: losses of up to 15% (all packages close)
  - Severely overfished: gains of up to 200%-300% (JC largest benefit)
- If tradeoff considered, good packages depend on fishing assumption outside:
  - "Good Management": JC (high fish, low econ), JD/XA (med fish, med econ) are reasonable
  - "Management Fails": All packages dominate no action in both dimensions. JC best.
  - Improved fishery management can significantly reduce any economic damage from MLPA
- Ranking of policies for biomass (by species or composite) insensitive to home range, larval dispersal, robust to assumptions about F
- Some very short dispersers (inverts) will still benefit biologically from MPAs but may not benefit economically, even under mgt. fails.
- If value to recreational sector measured by equilibrium Effort, all packages increase benefits to that sector.

41