

Package Evaluation by the Delay-Difference Model

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January 23, 2008
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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

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.

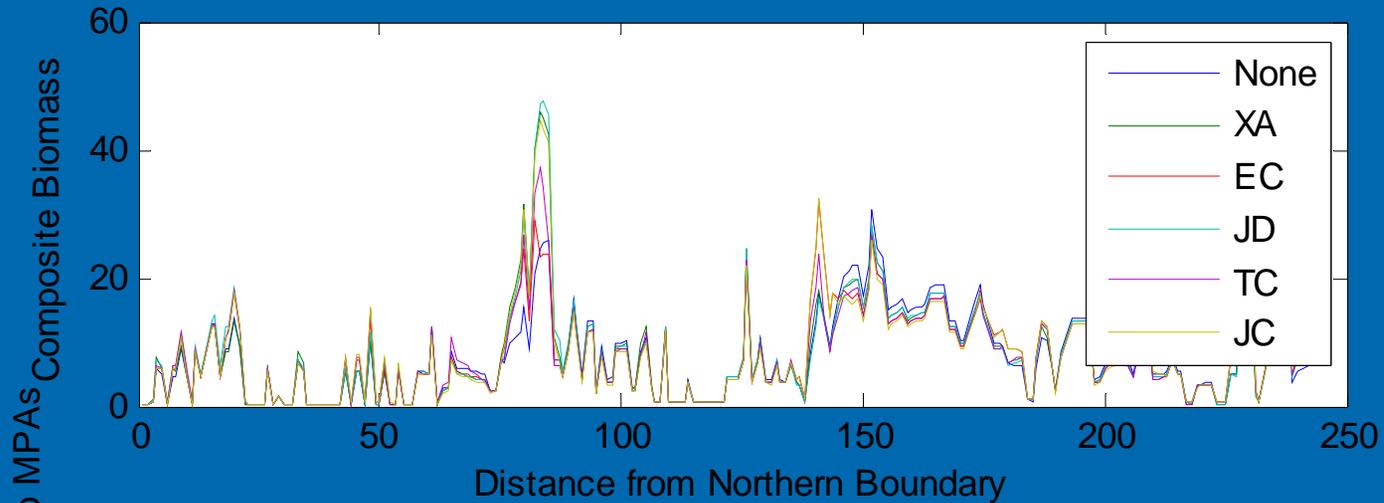
Base Case Parameterization

➤ Base Case

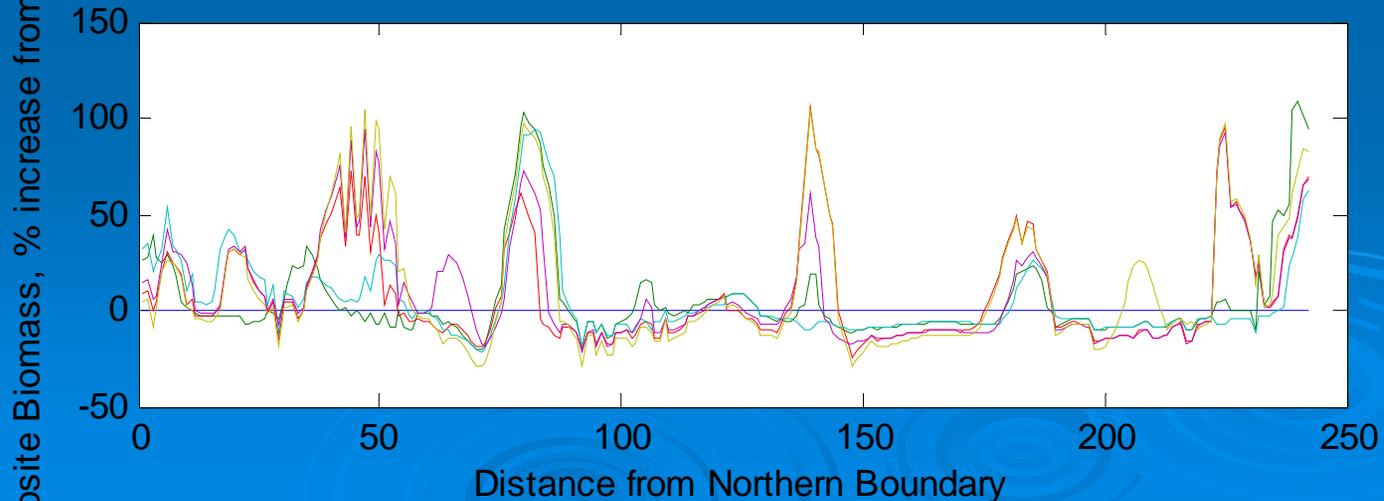
- 5 species (Lingcod, Cabezon, Black Rockfish, Canary Rockfish, California Halibut)
 - Home range radius (.5 km - 10 km)
 - S.D. Gaussian larval dispersal (10 km – 45 km)
- Fishing effort outside reserves
 - “Good Management” (fleet model with $F=.05$)
 - “Poor Management” (fleet model with $F=.10$)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

Spatial Biomass (F=.05)

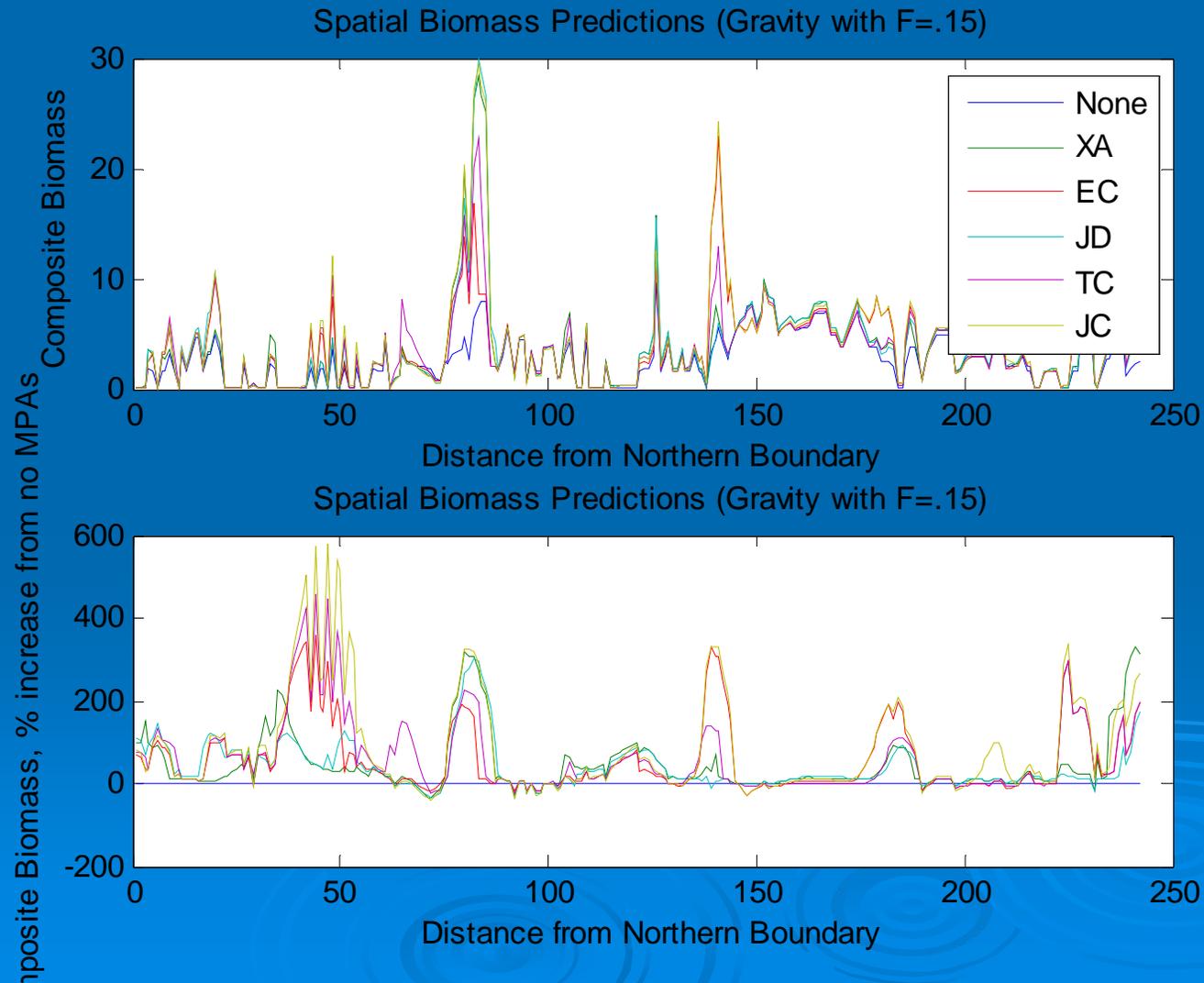
Spatial Biomass Predictions (Gravity with F=.05)



Spatial Biomass Predictions (Gravity with F=.05)



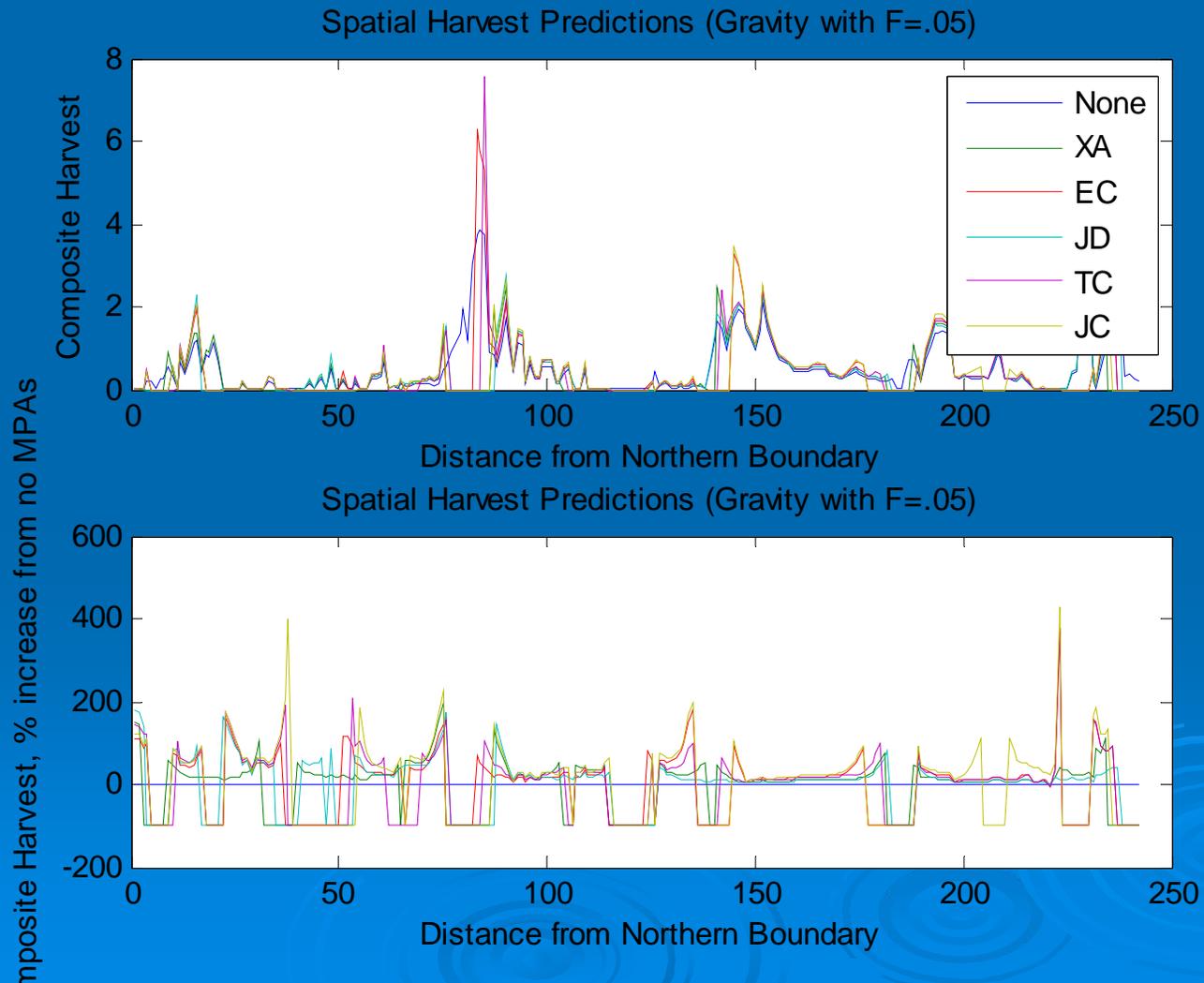
Spatial Biomass (F=.15)



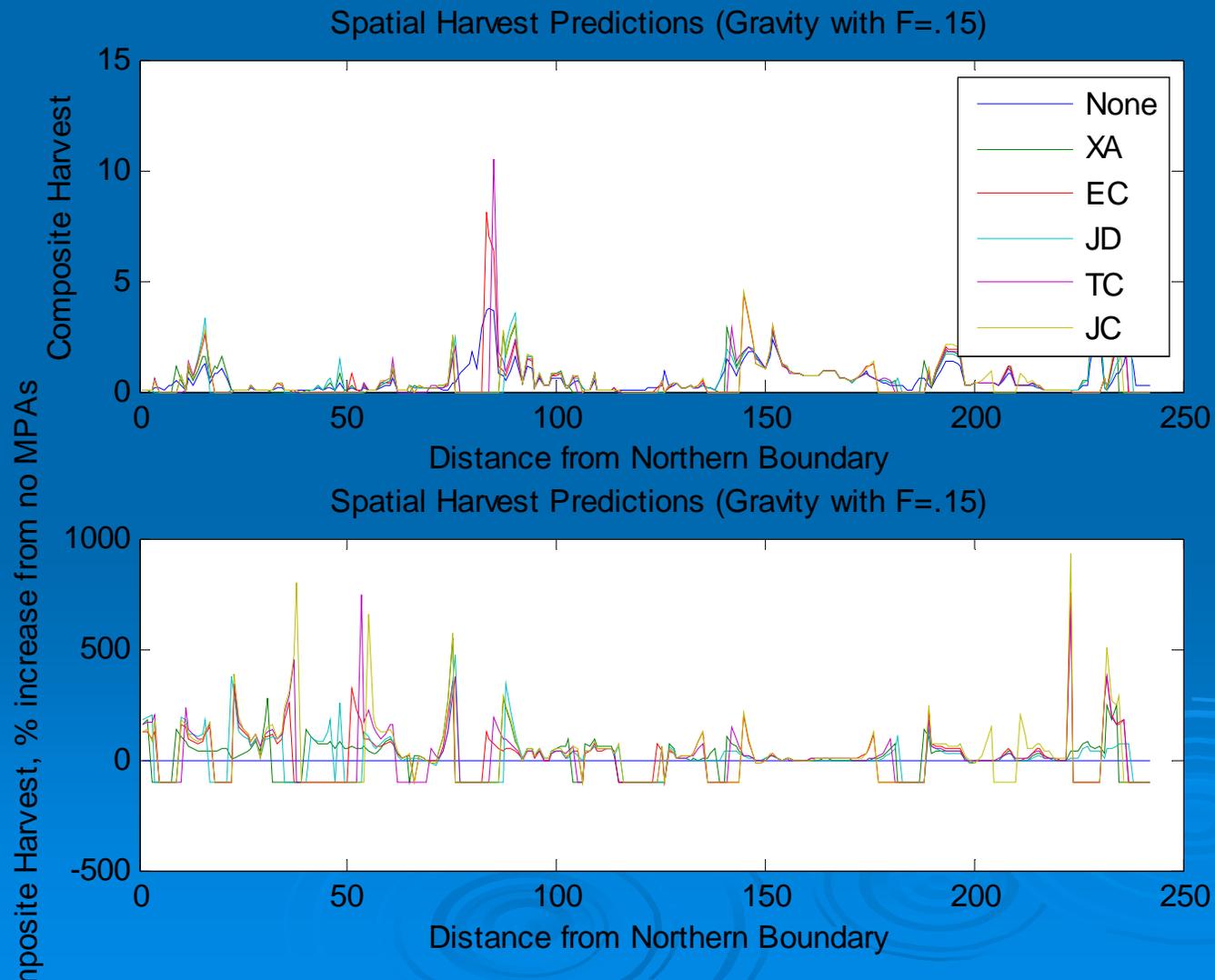
Summary of spatial biomass

- 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%

Spatial Harvest ($F=.05$)



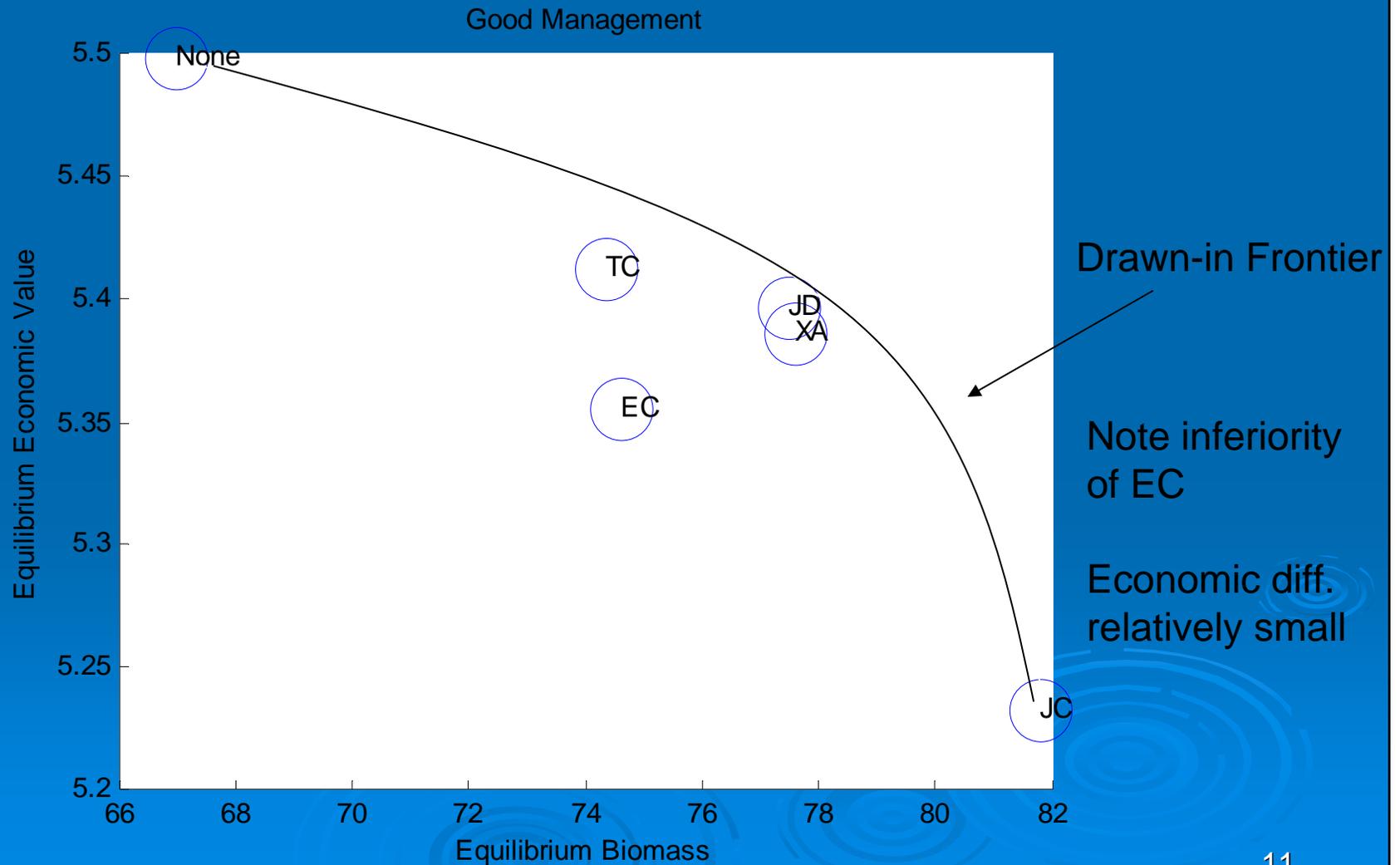
Spatial Harvest ($F=.15$)



Summary of spatial harvest

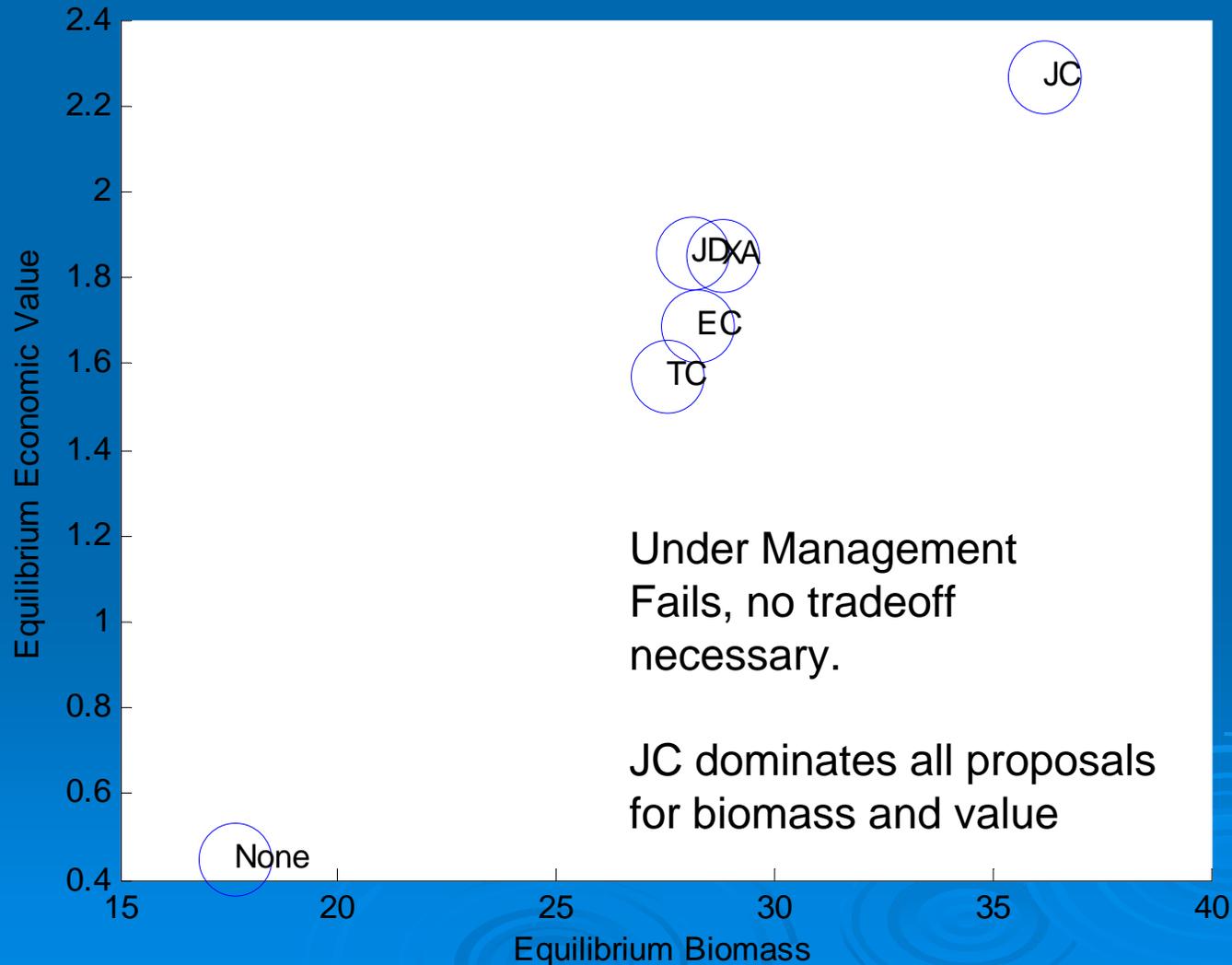
- Under “Good Management”:
 - Equilibrium harvest increases in some areas (spillover) and decreases in others (reserve)
 - Harvest increases in: 63% of patches (JC) to 75% of patches (XA and JD), decreases in complement.
- Under “Management Fails”:
 - Harvest can be significantly higher in certain open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

Biomass vs. Economics (F=.05)

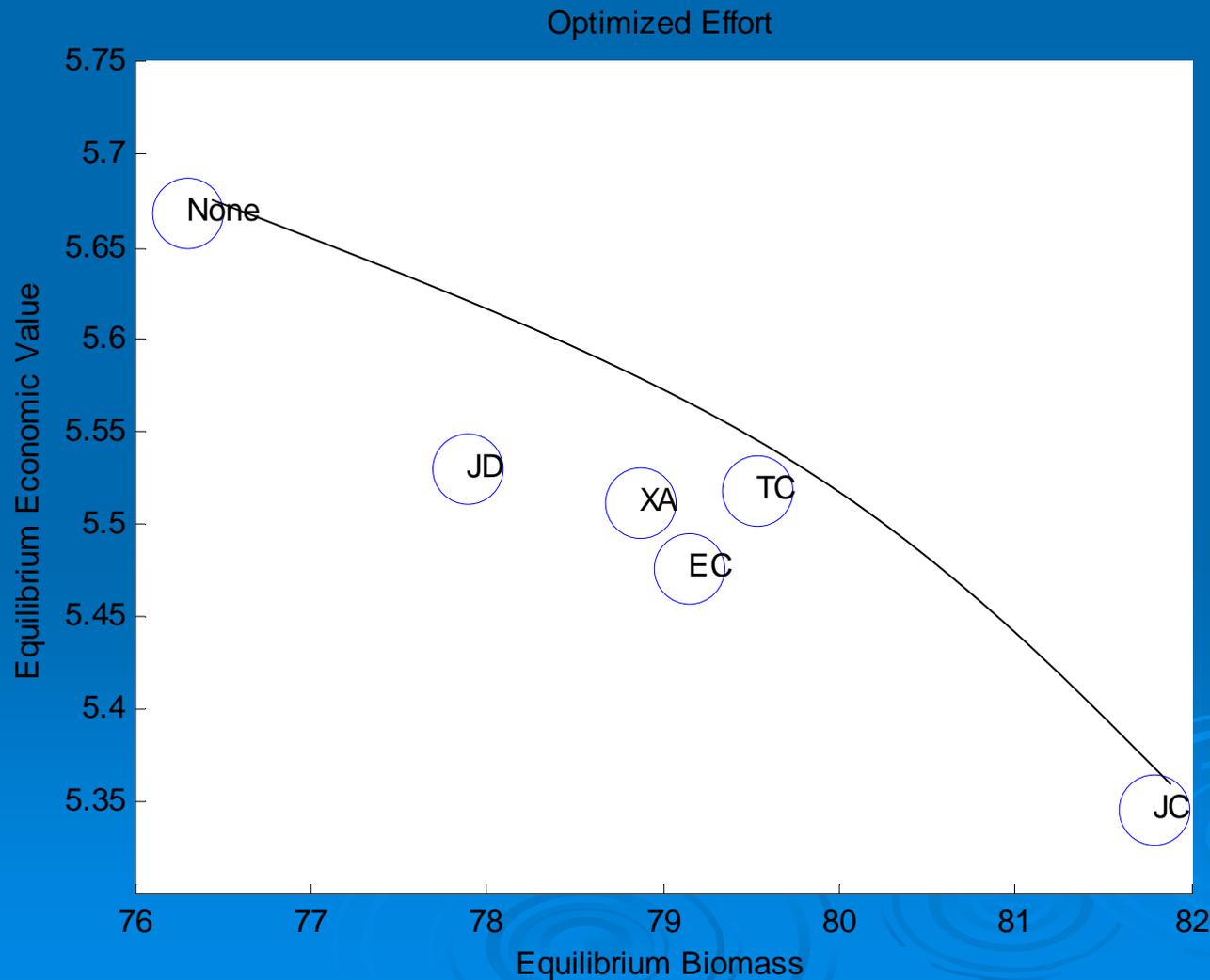


Biomass vs. Economics (F=.15)

Management Fails



Biomass vs. Economics (Optimized for Economic Profit)



More-or-less
Linear tradeoff

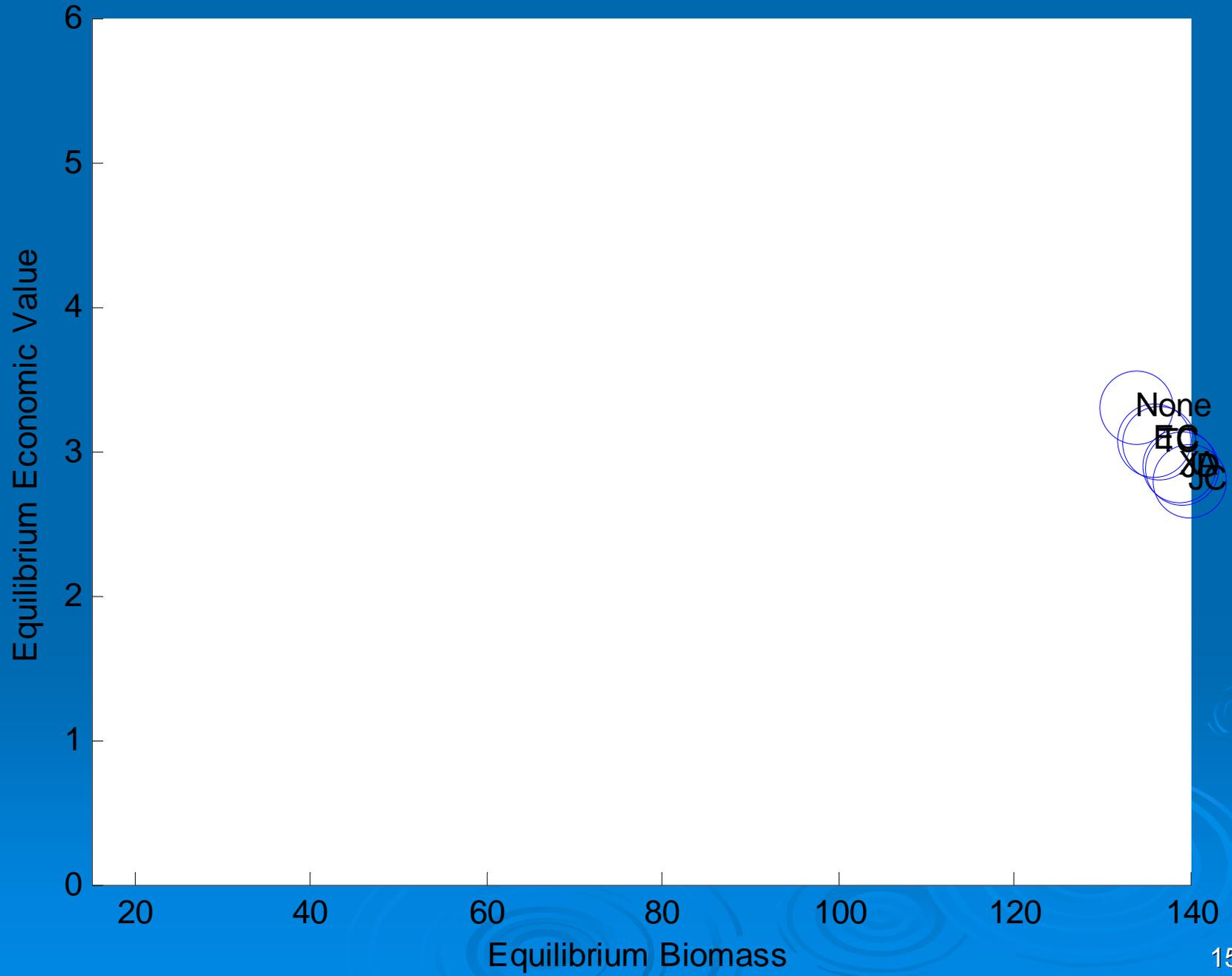
Relatively small
diff. in value
and biomass

TC and JC
tend to dominate

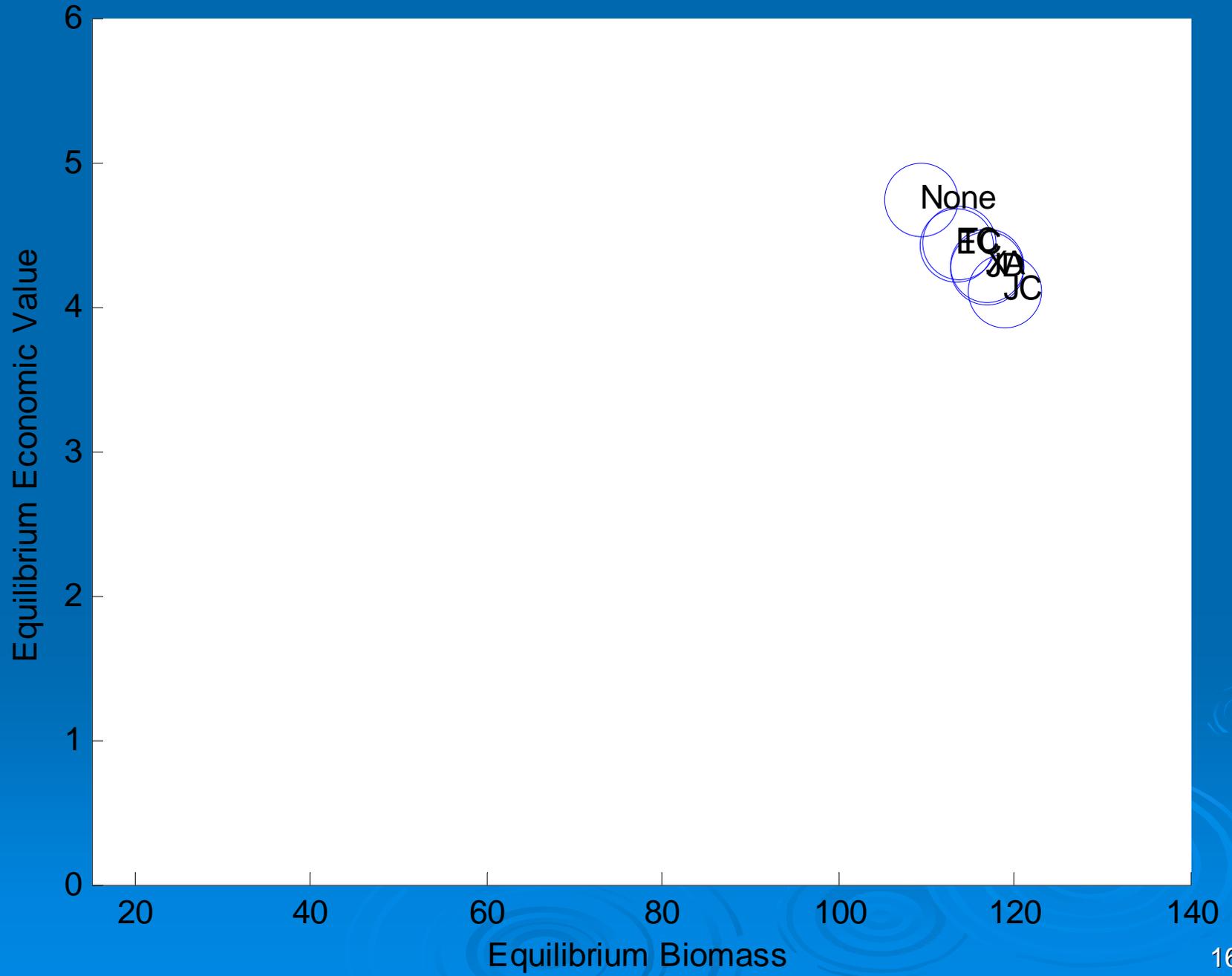
How bad does management have to be?

- 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?

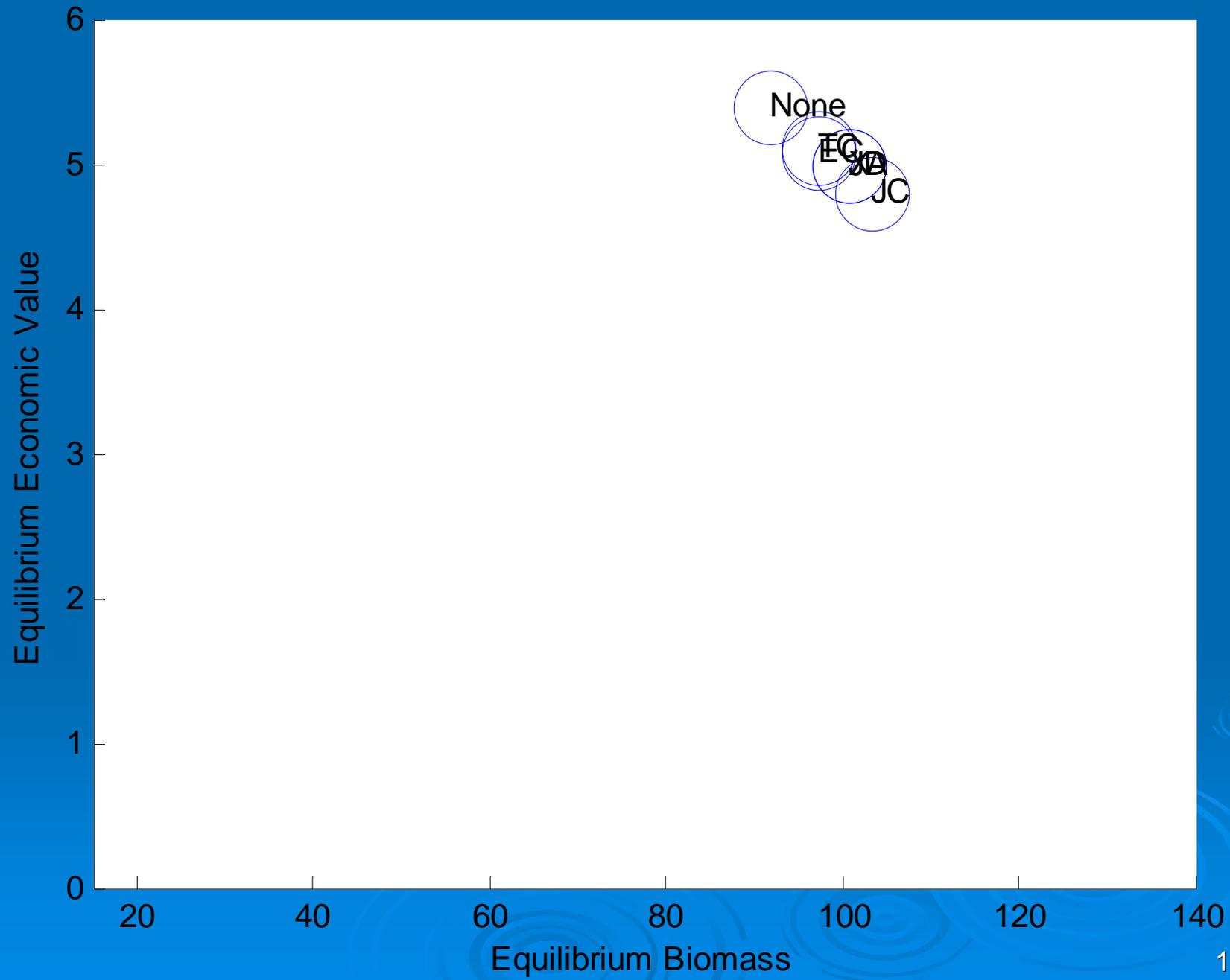
F=0.01



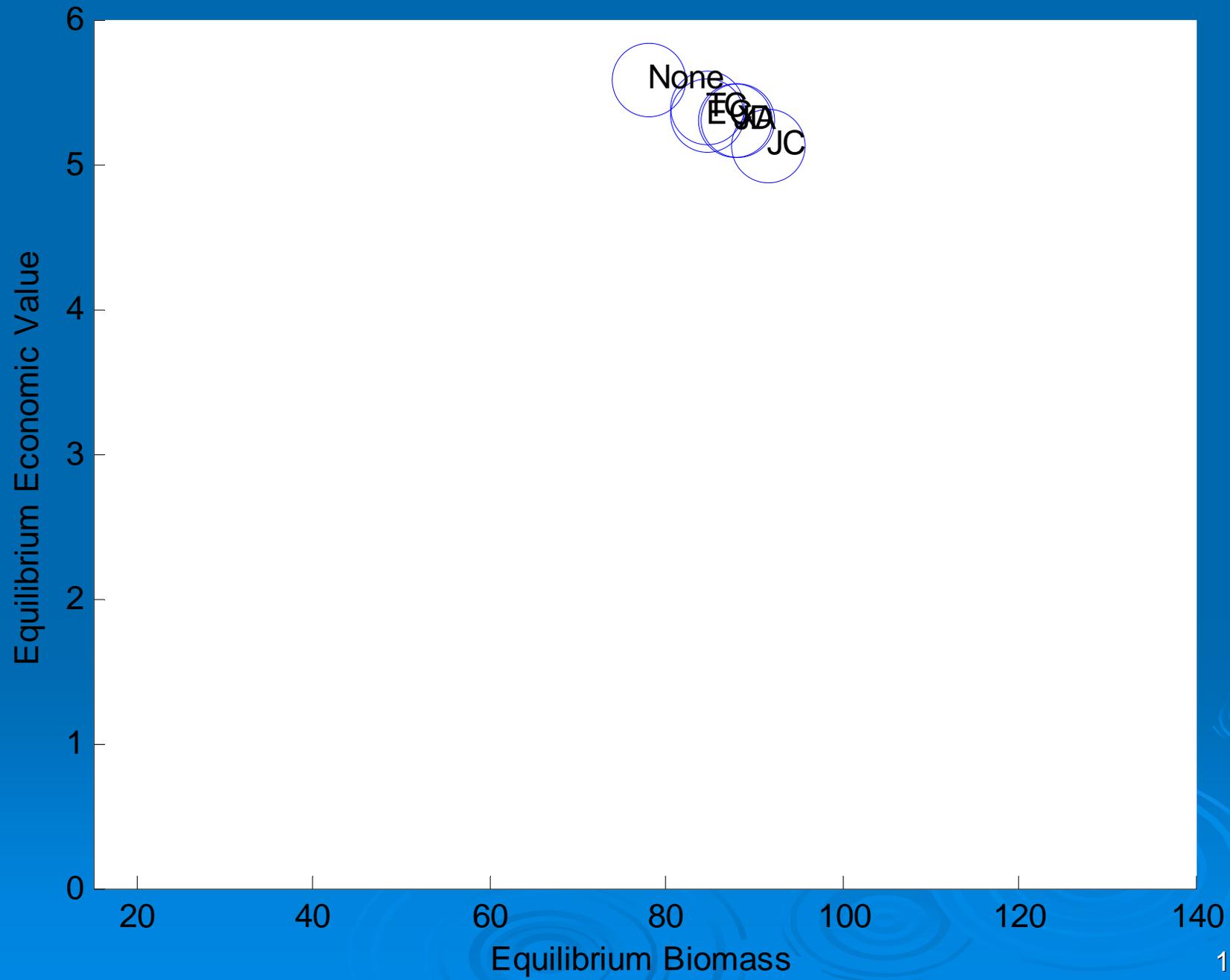
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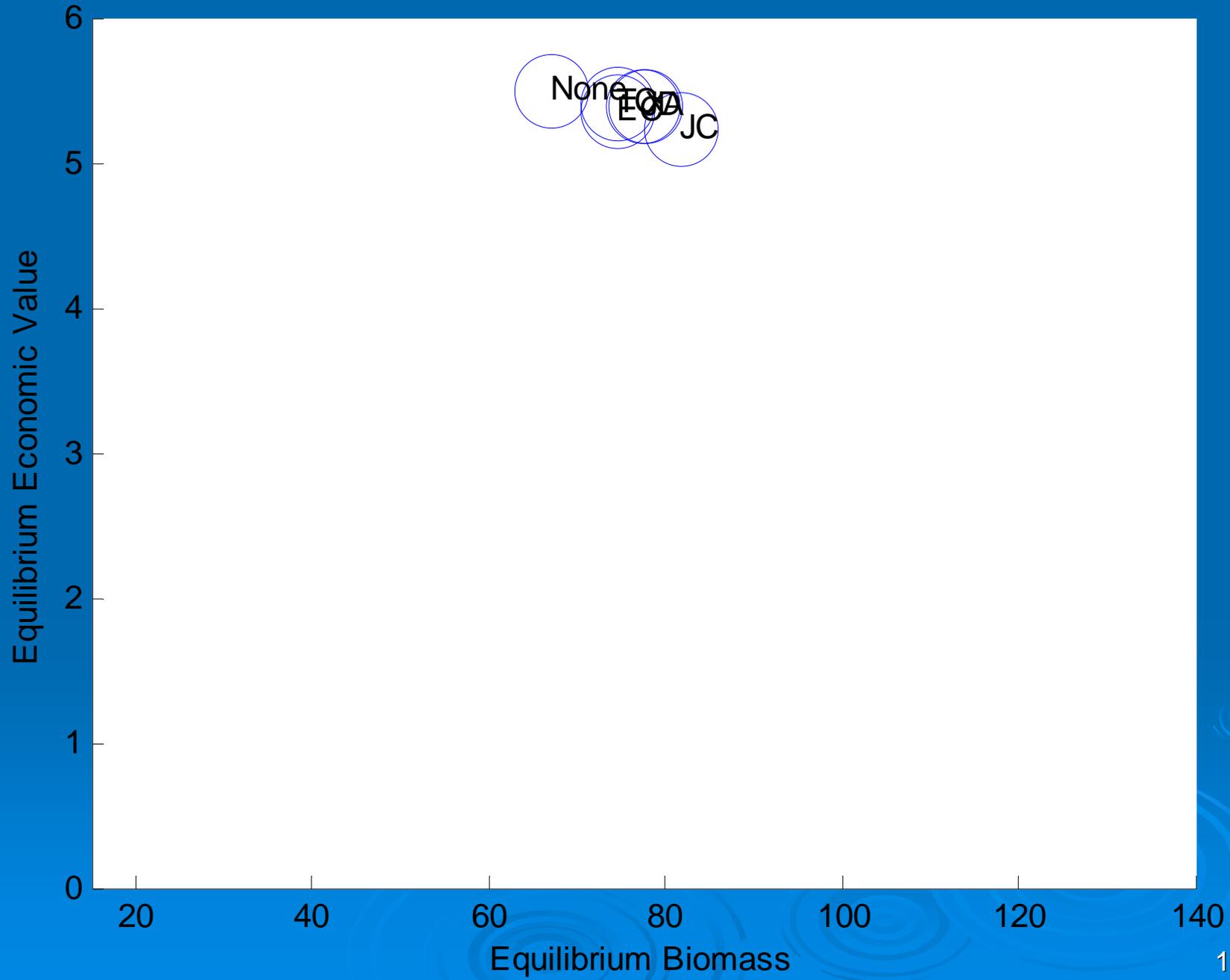
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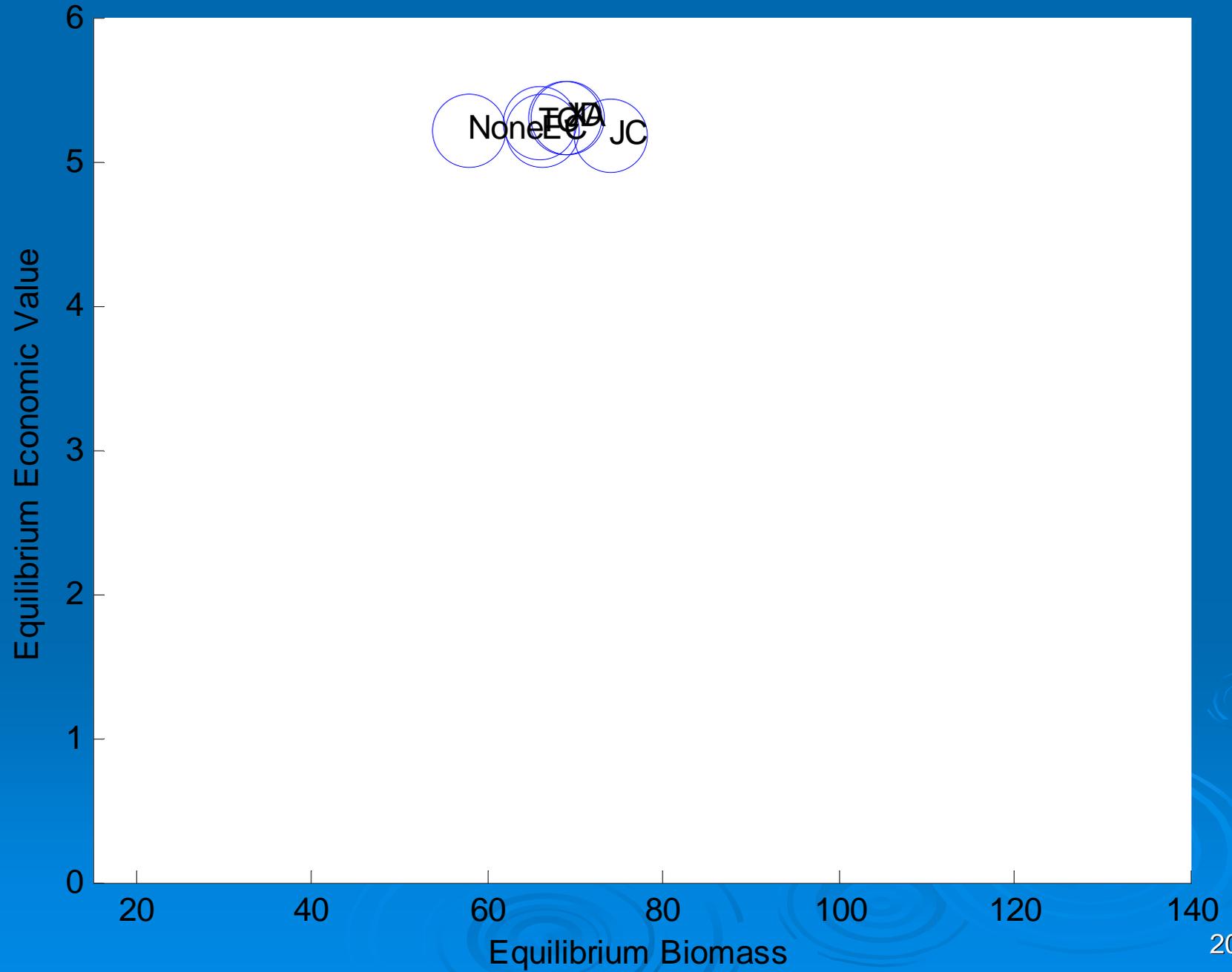
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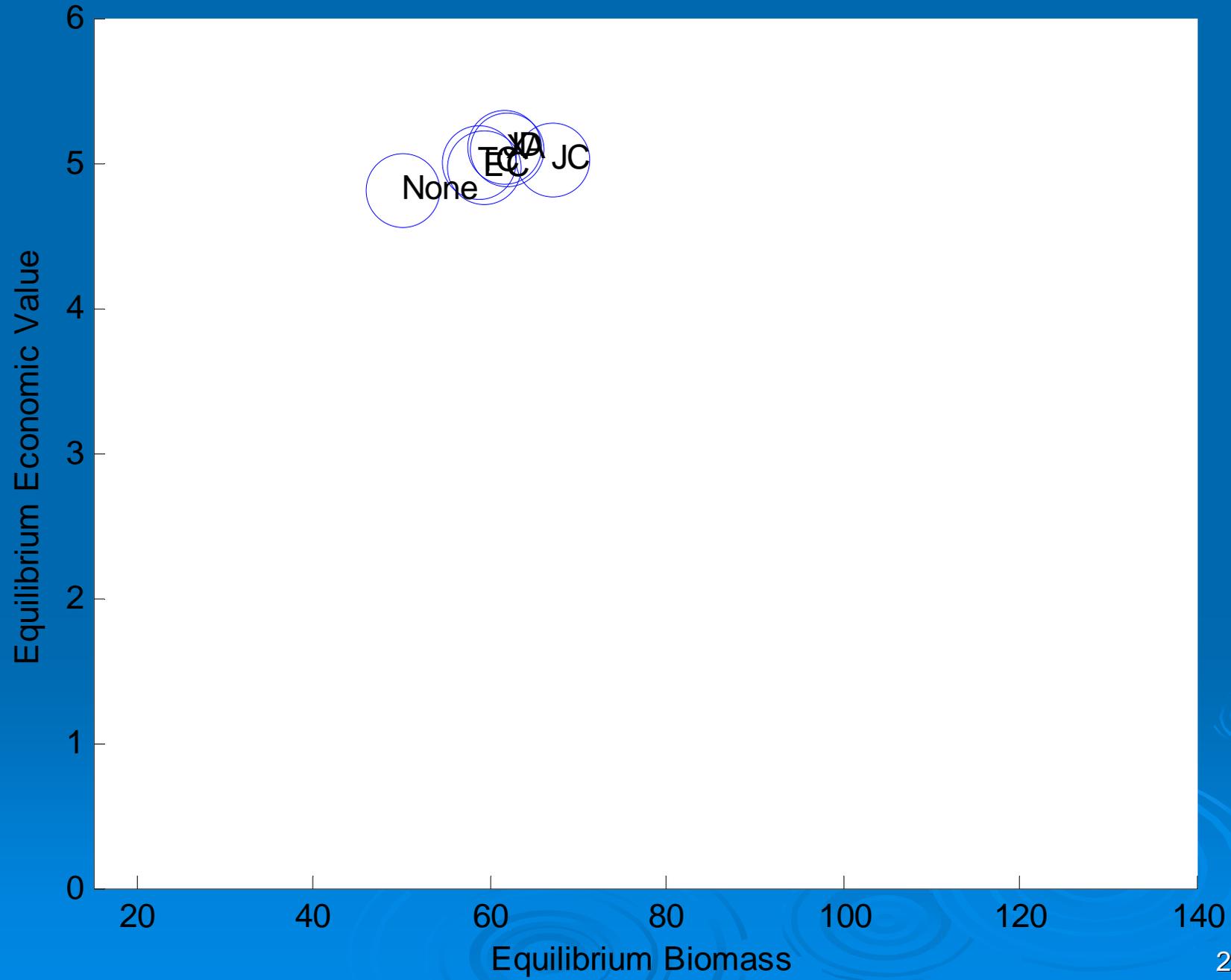
F=0.05



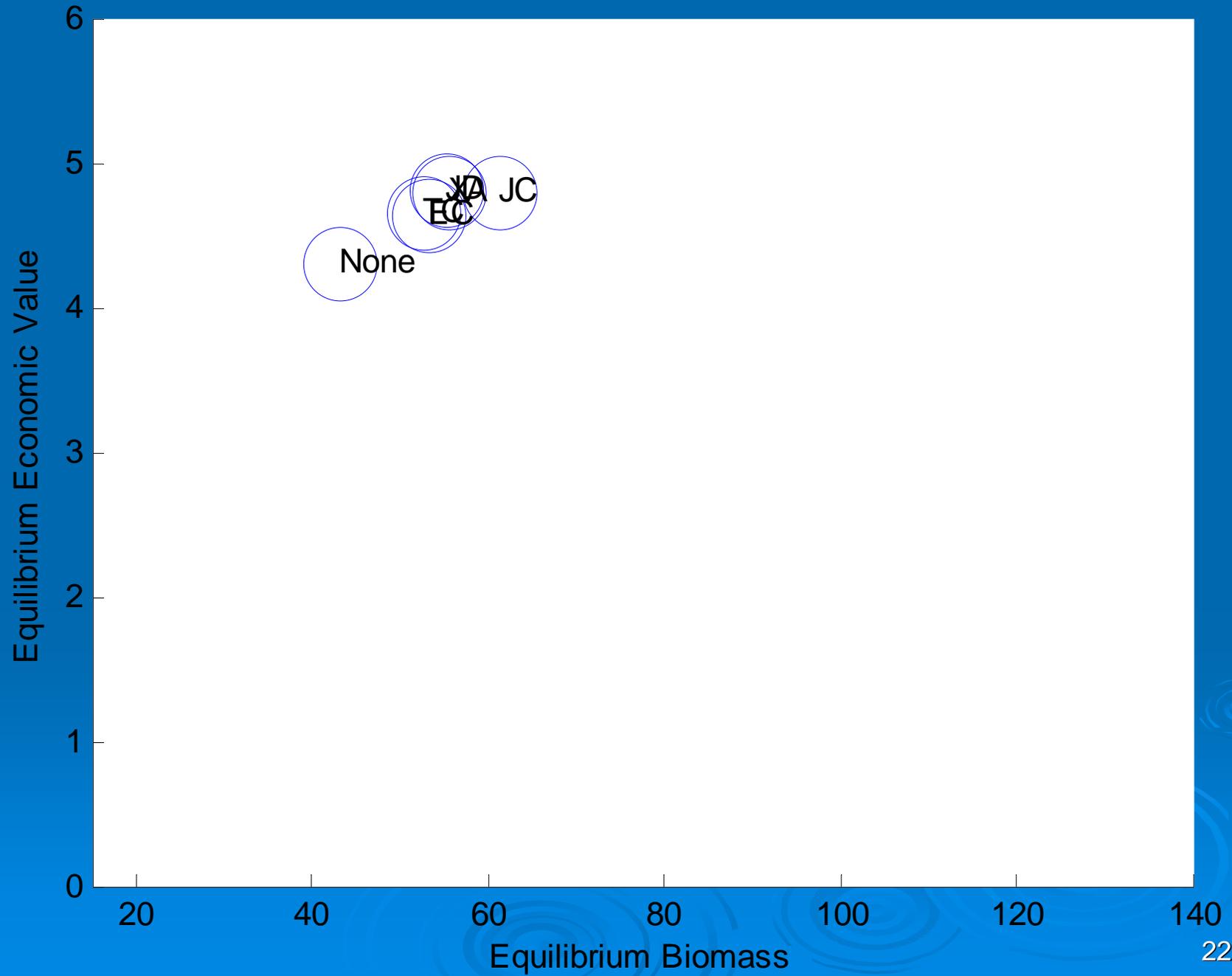
F=0.06



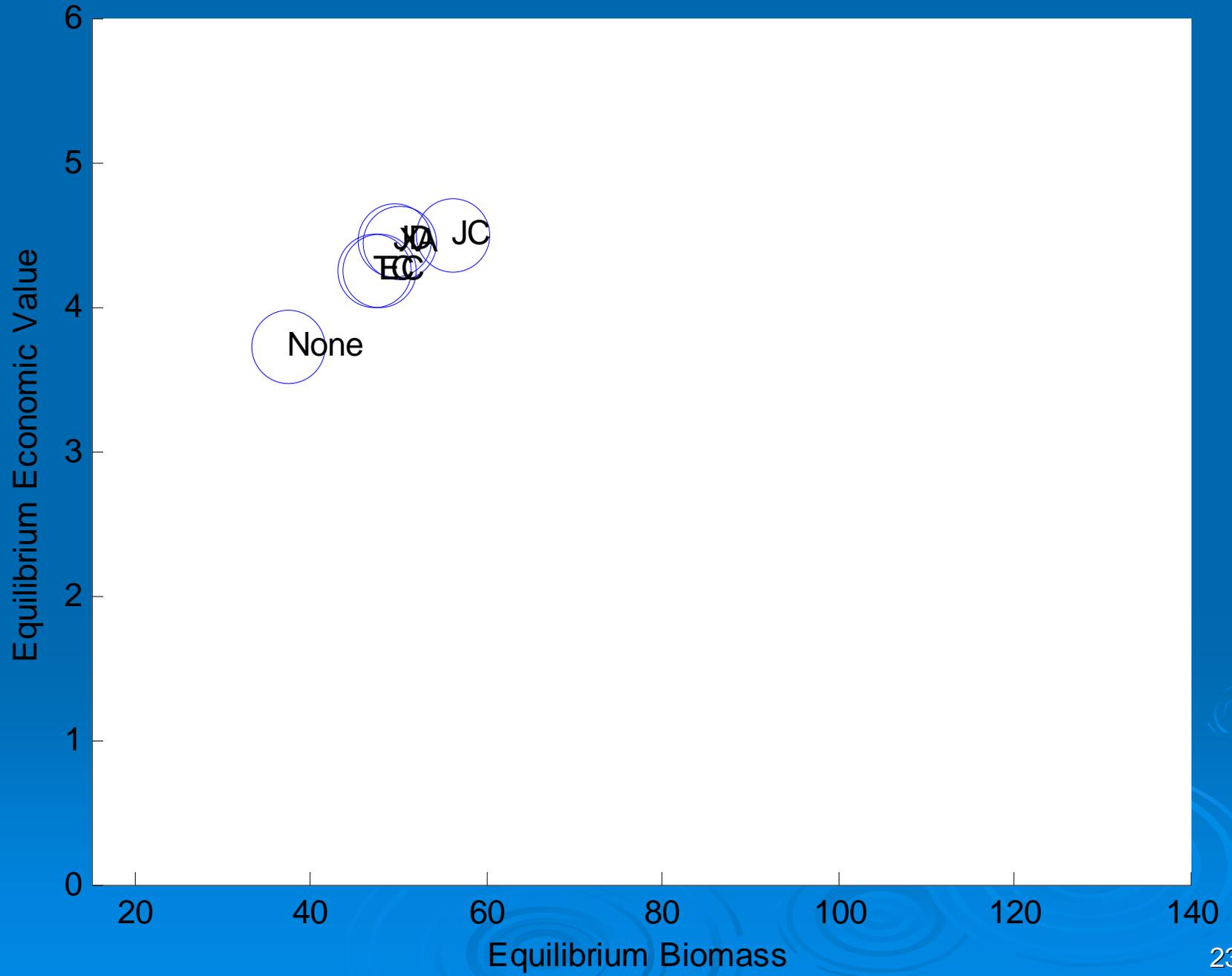
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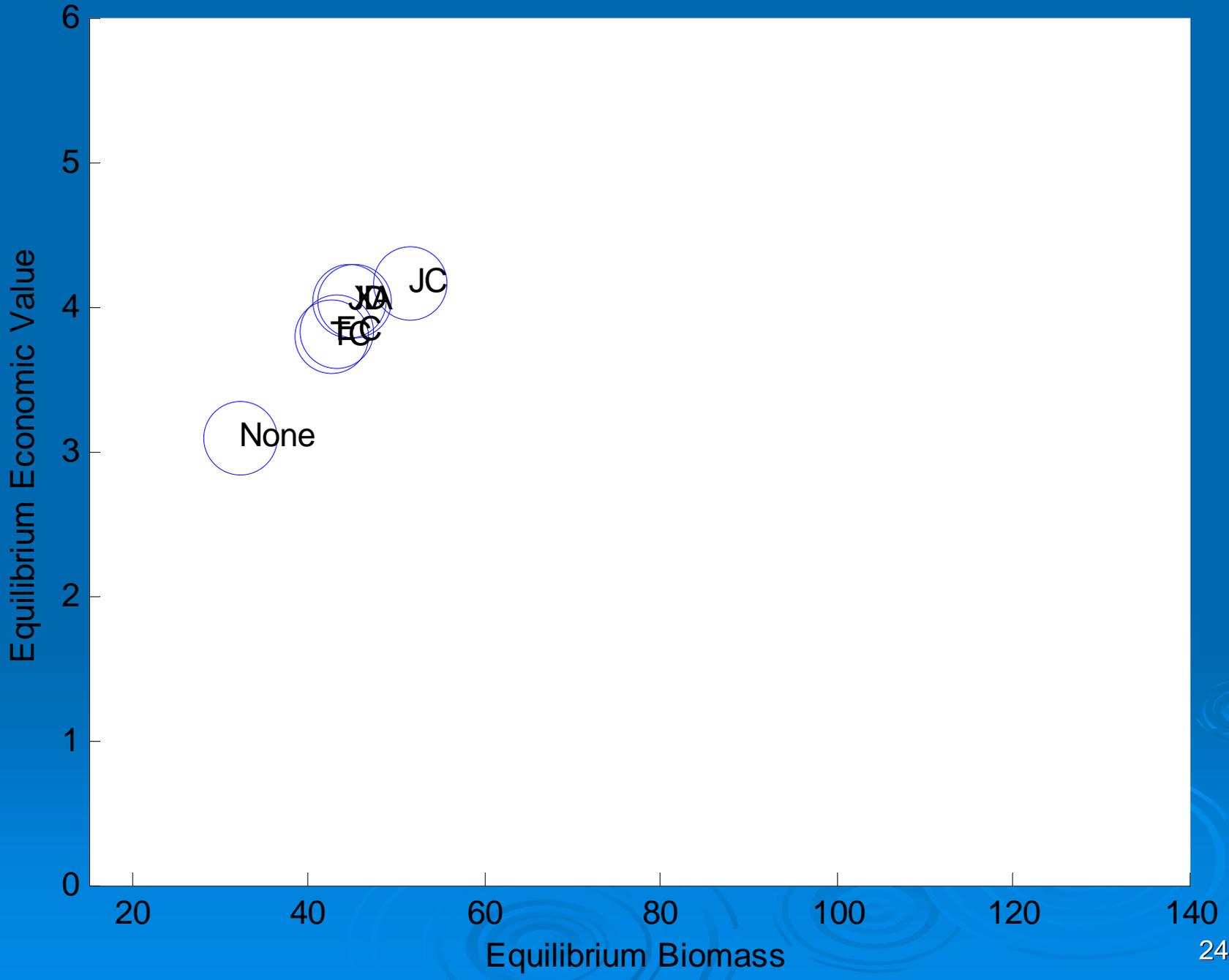
F=0.08



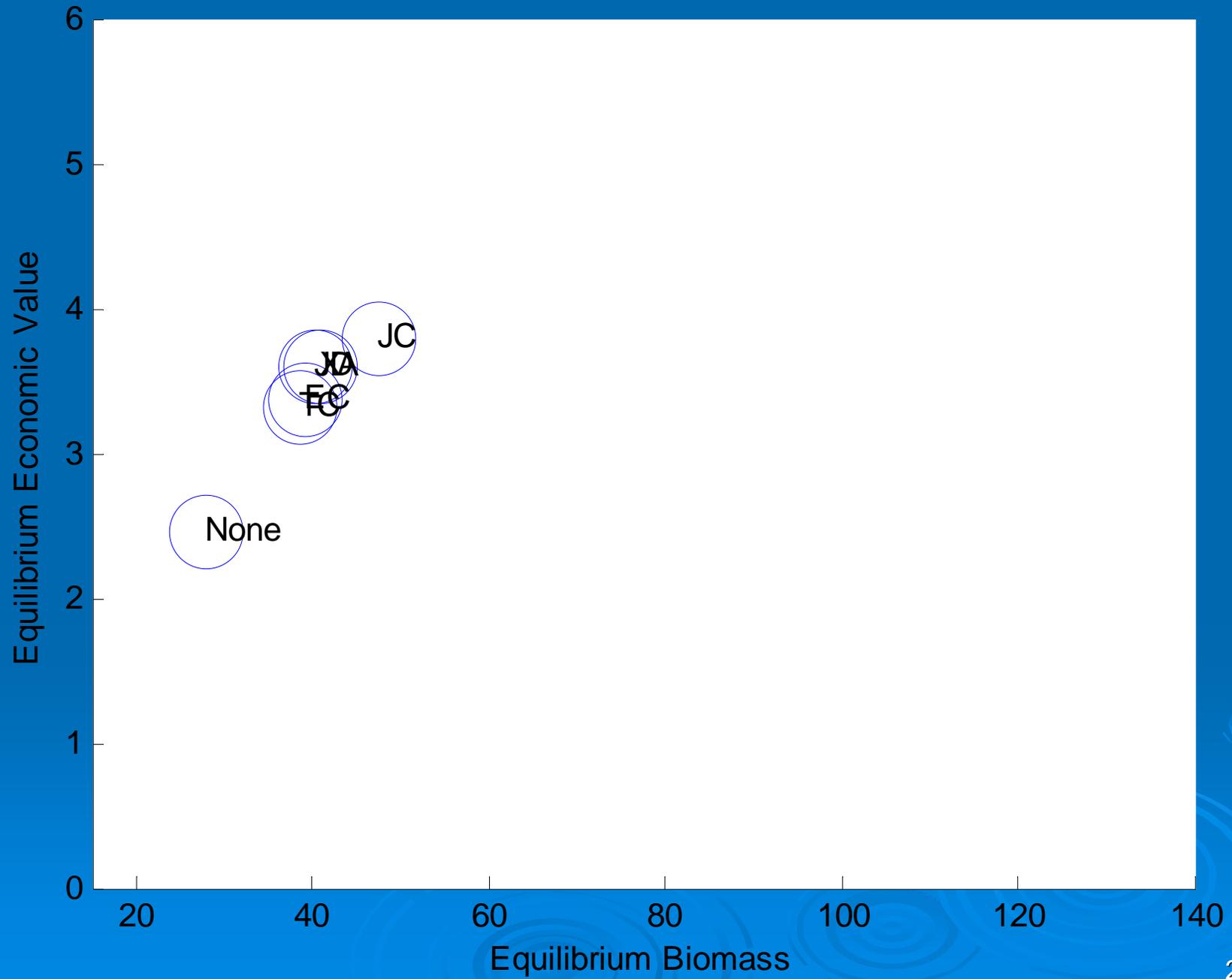
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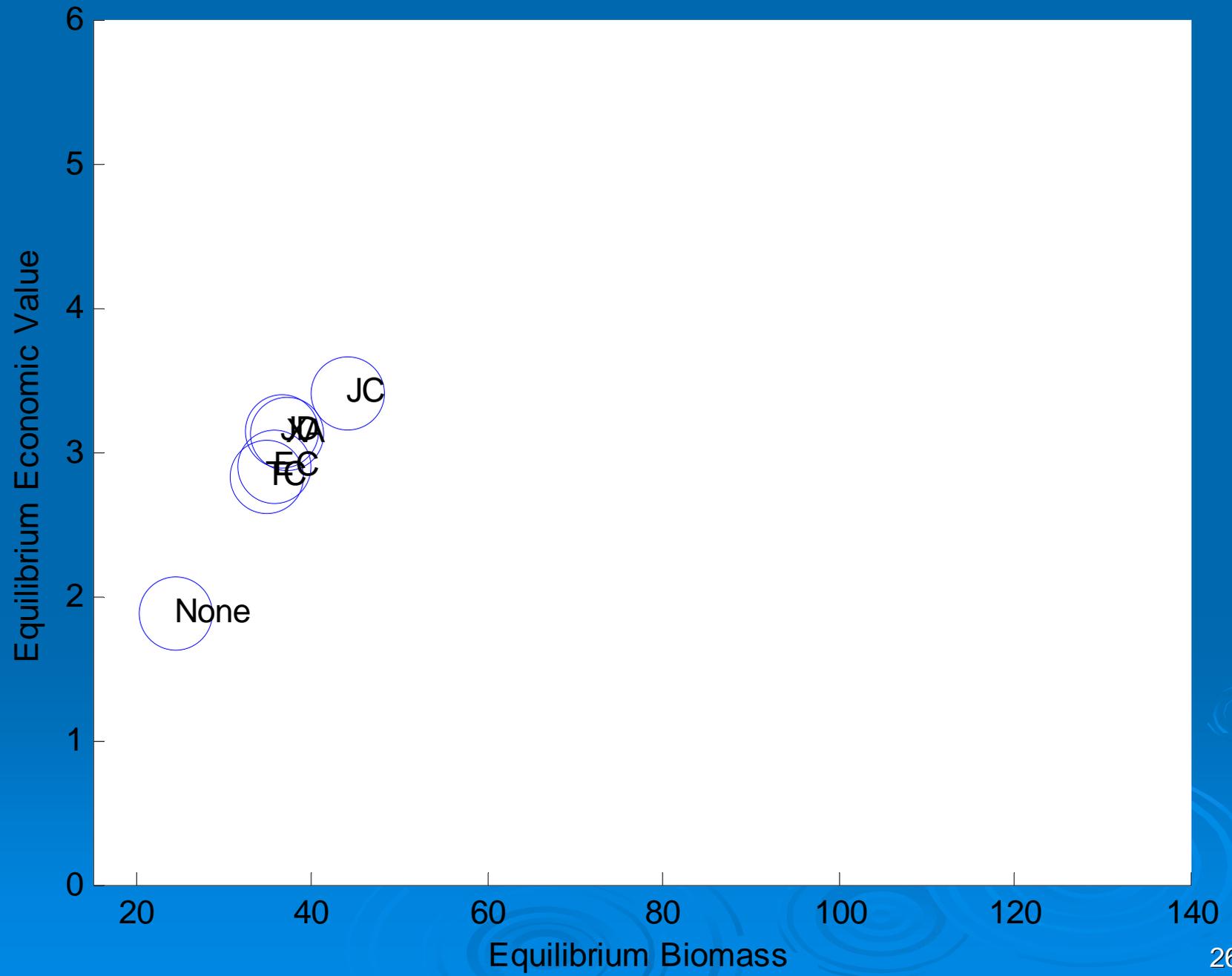
F=0.1



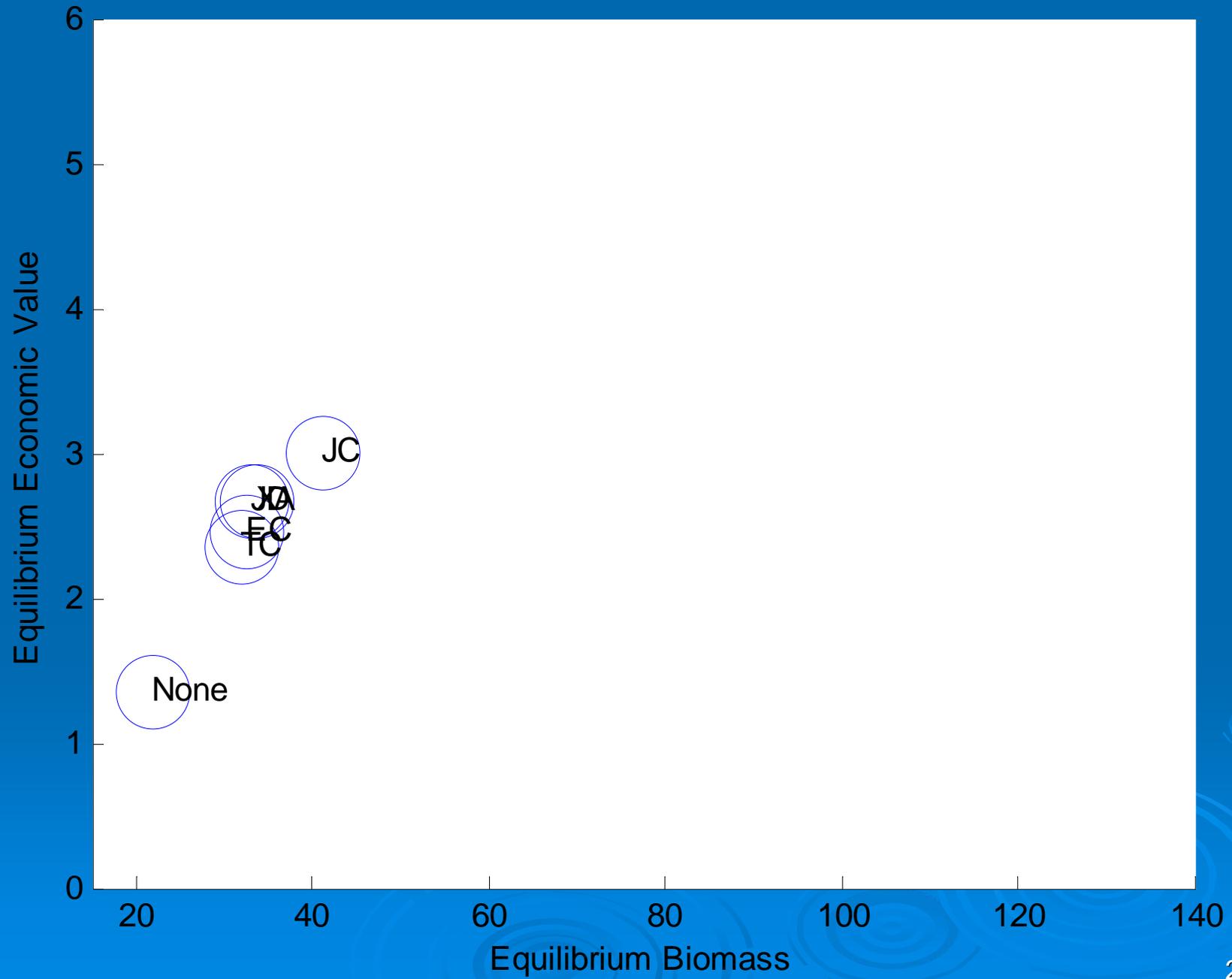
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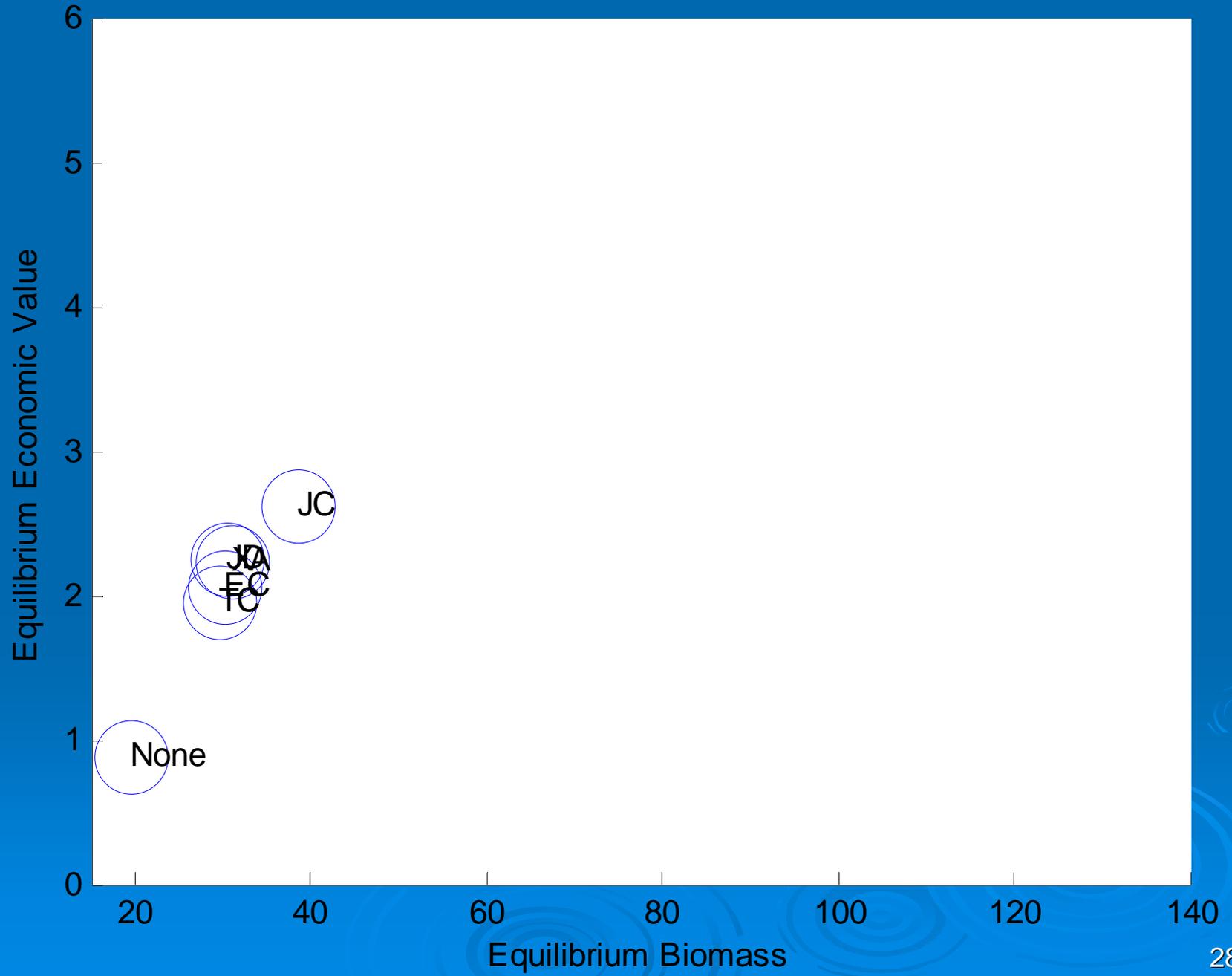
F=0.12



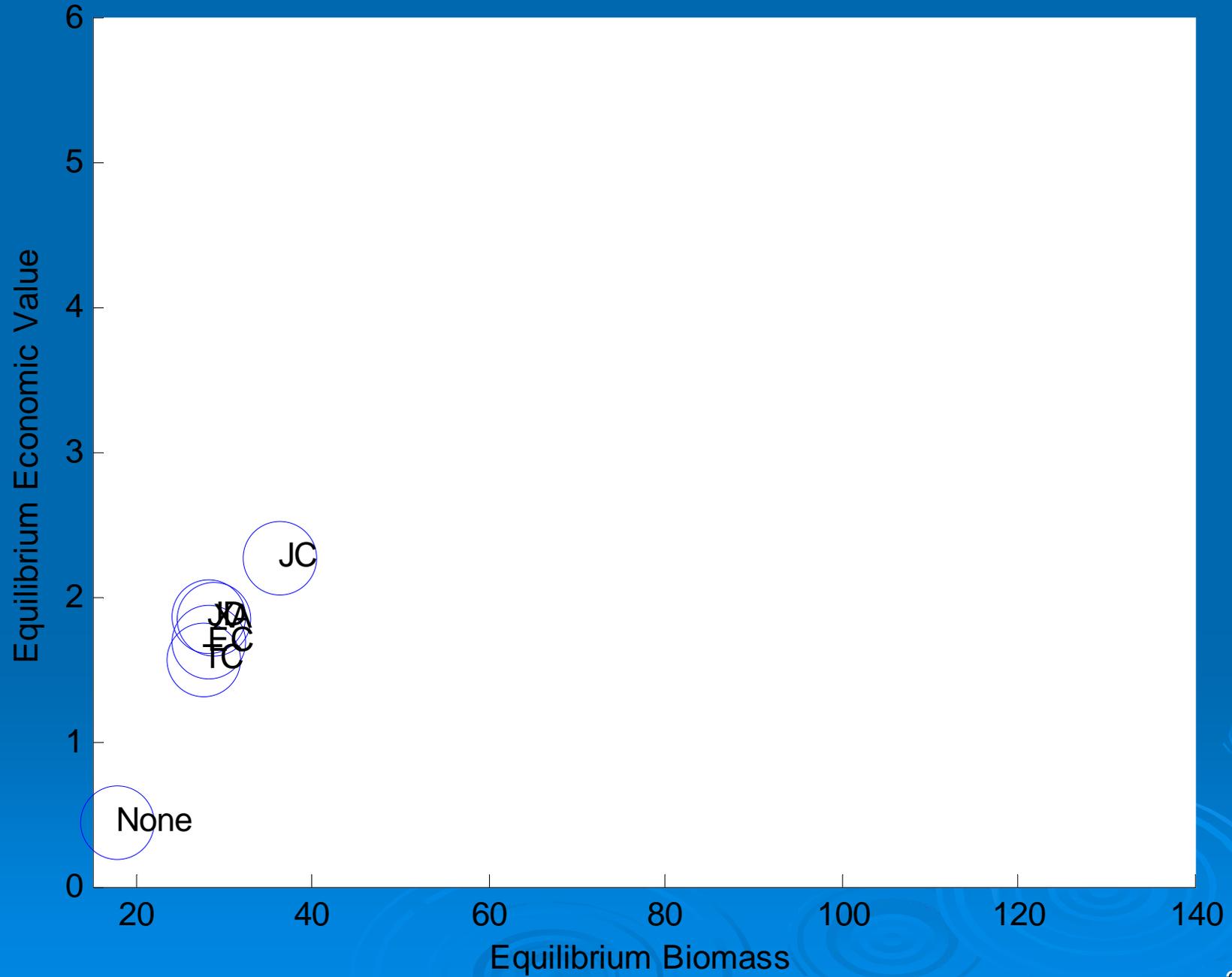
F=0.13



F=0.14



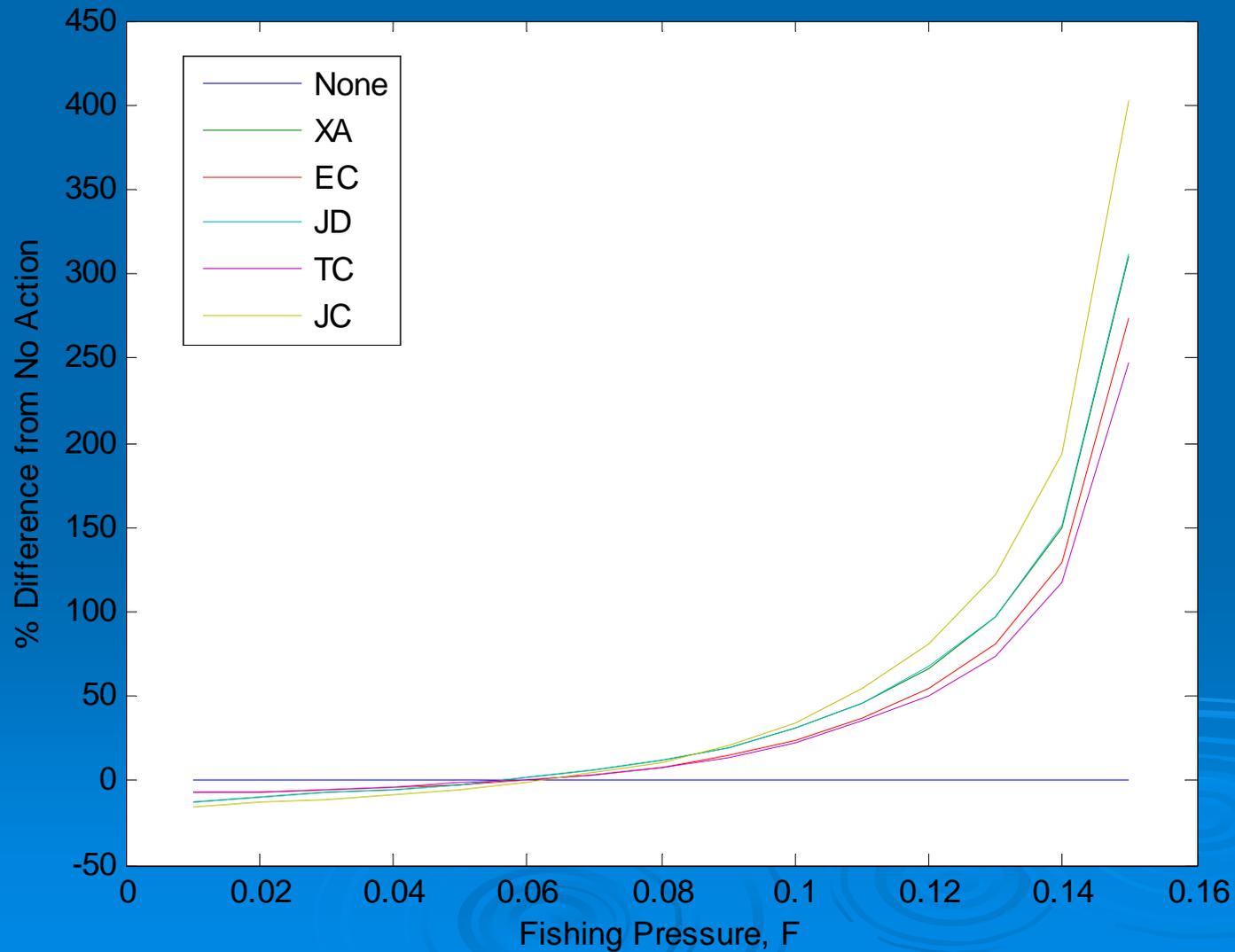
F=0.15



How bad does management have to be?

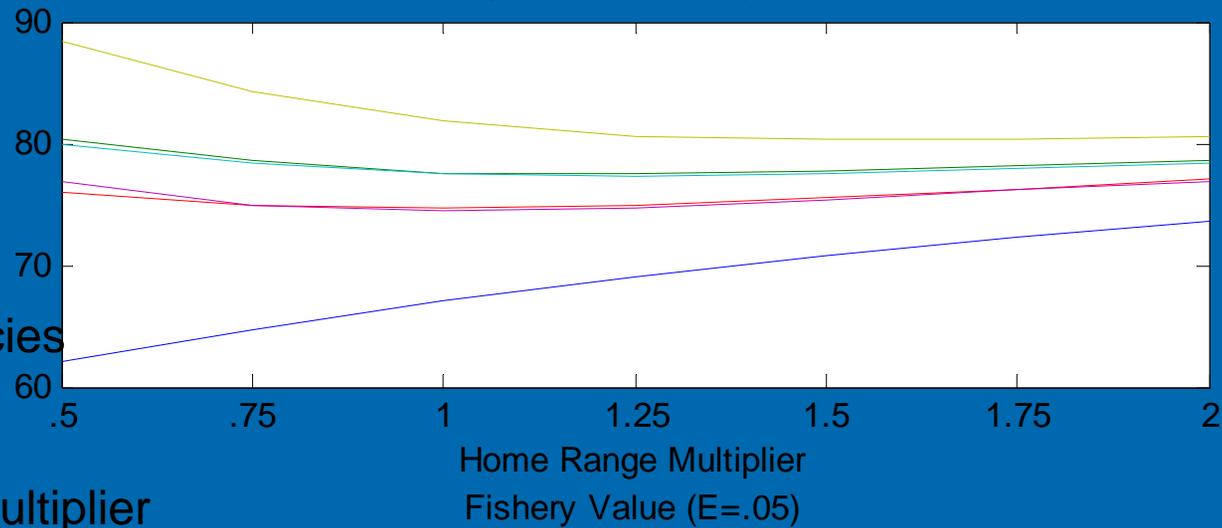
- If $F > 0.06$, all packages are win-win from economic and biological point of view
- JC always dominate biological outcome
- For pretty bad management (.06-.08) JD and XA dominate economics
- For management fails JC dominates both
- The more overfished you think the fishery will be in the future, the more you should like JC (goes for fishermen and conservationists)

Economic Profit vs. Fishing Pressure



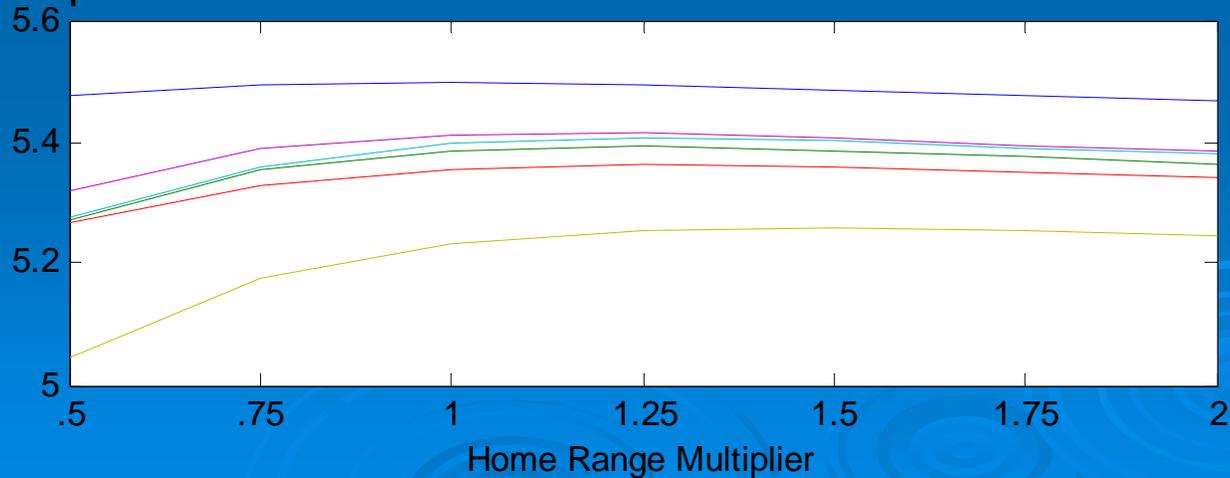
Sensitivity Analysis: Home Range ($F=.05$)

Composite Biomass ($E=.05$)

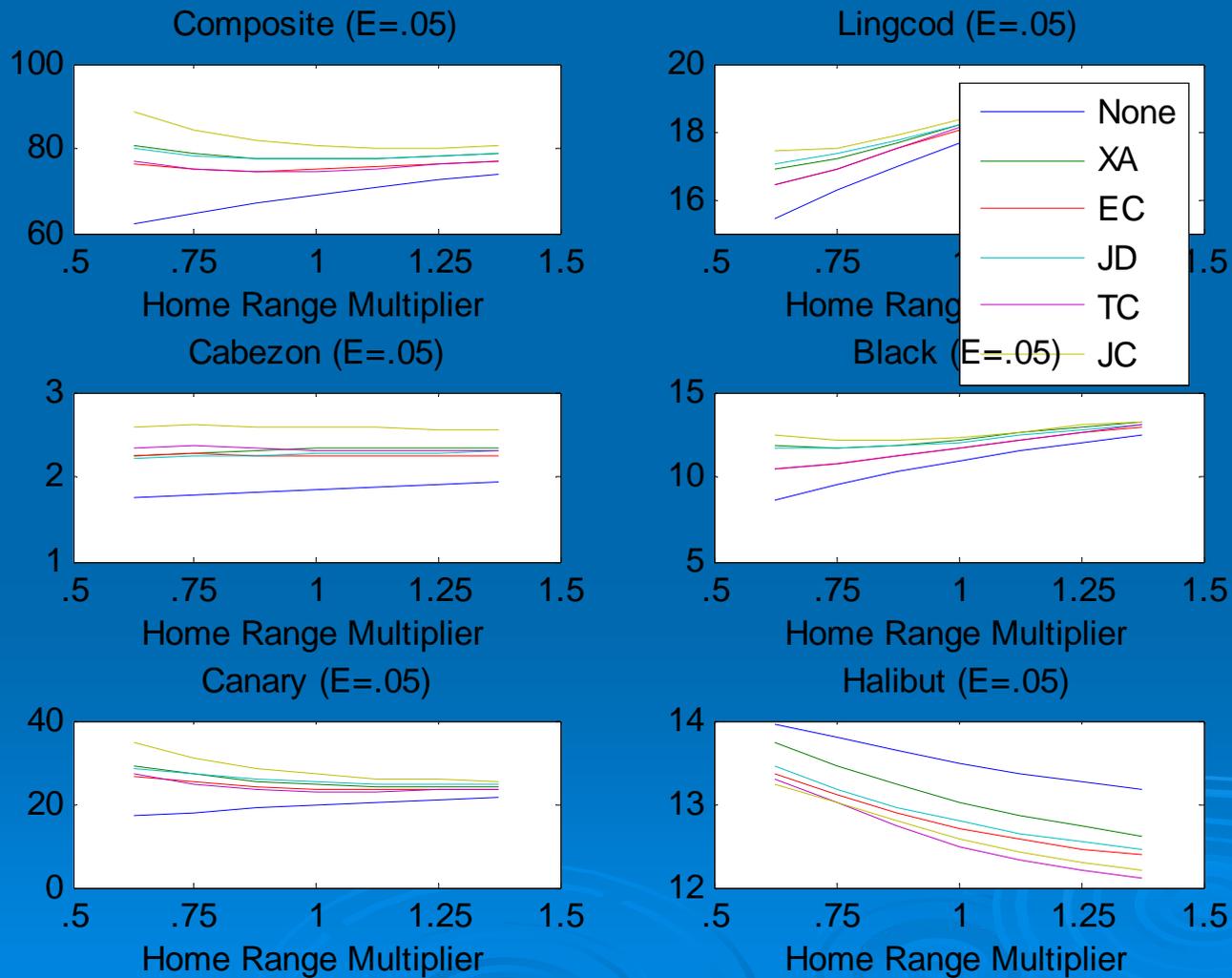


Ranking of policies
for biomass is
insensitive to
Home Range Multiplier

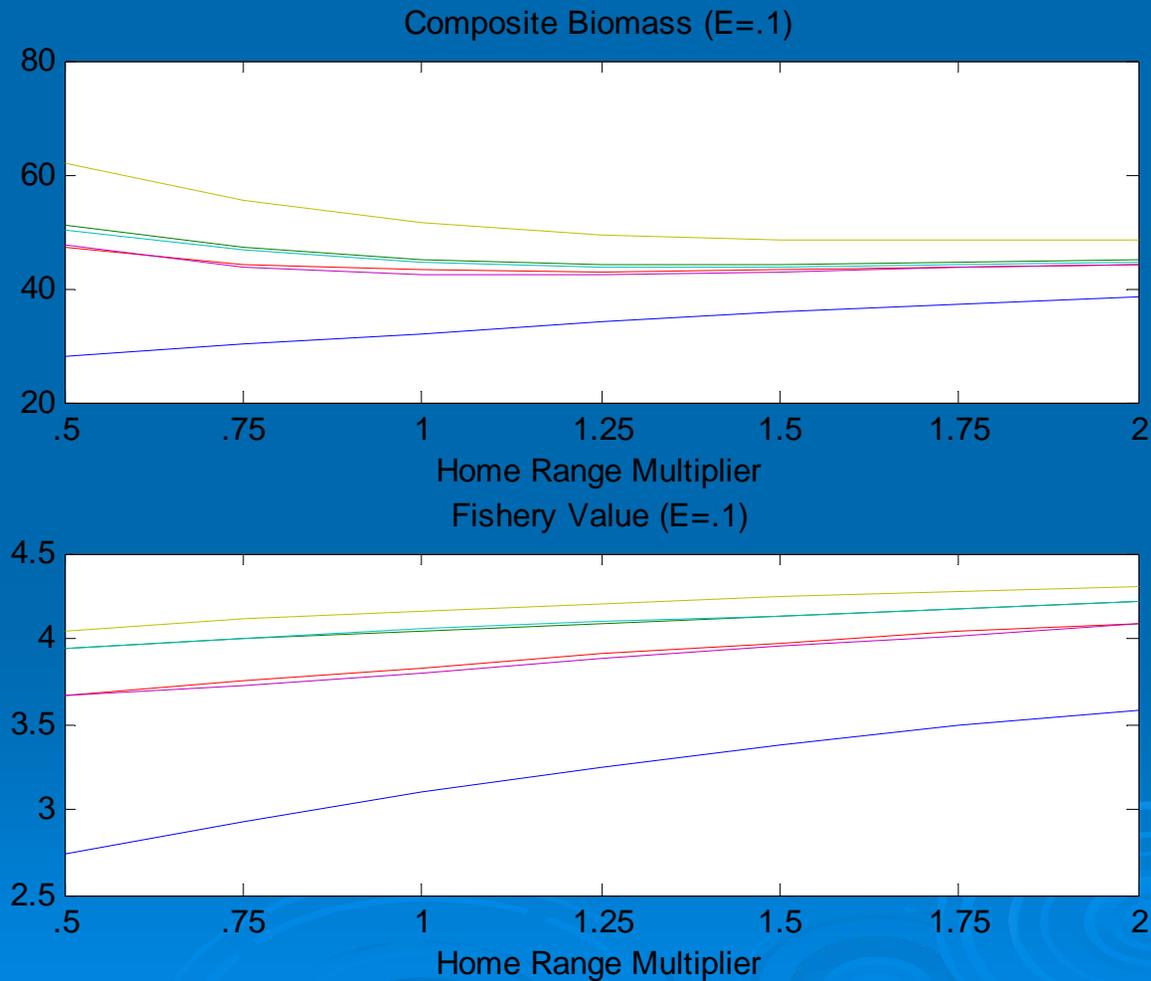
Fishery Value ($E=.05$)



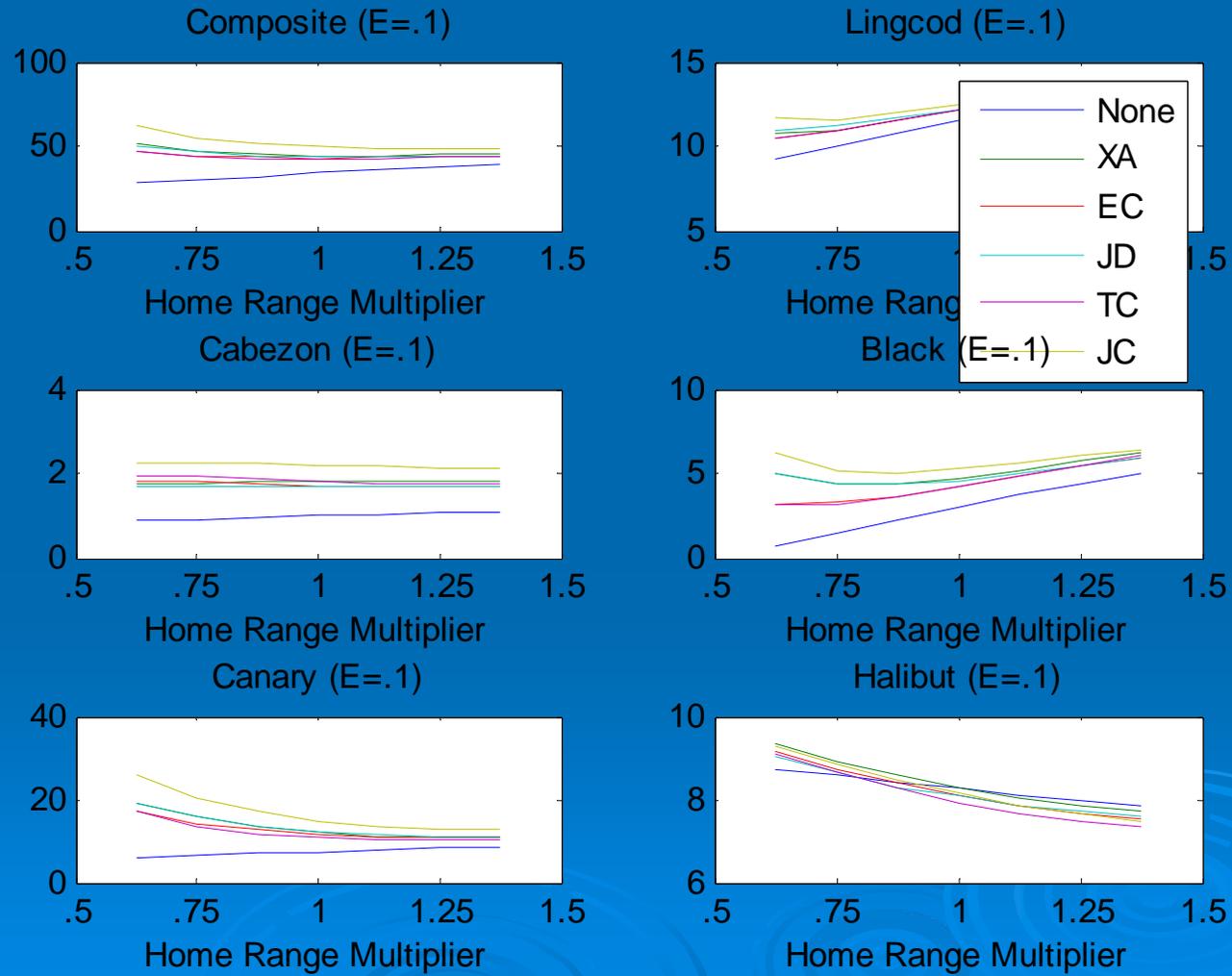
Home Range (species-by-species)



Sensitivity to Home Range ($F=.1$)

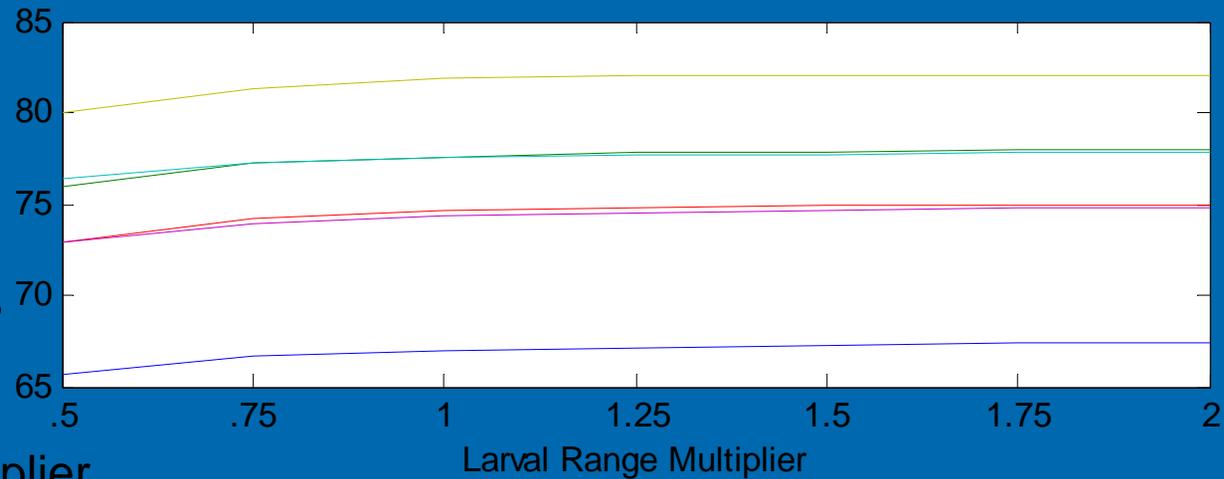


Home Range (species-by-species)



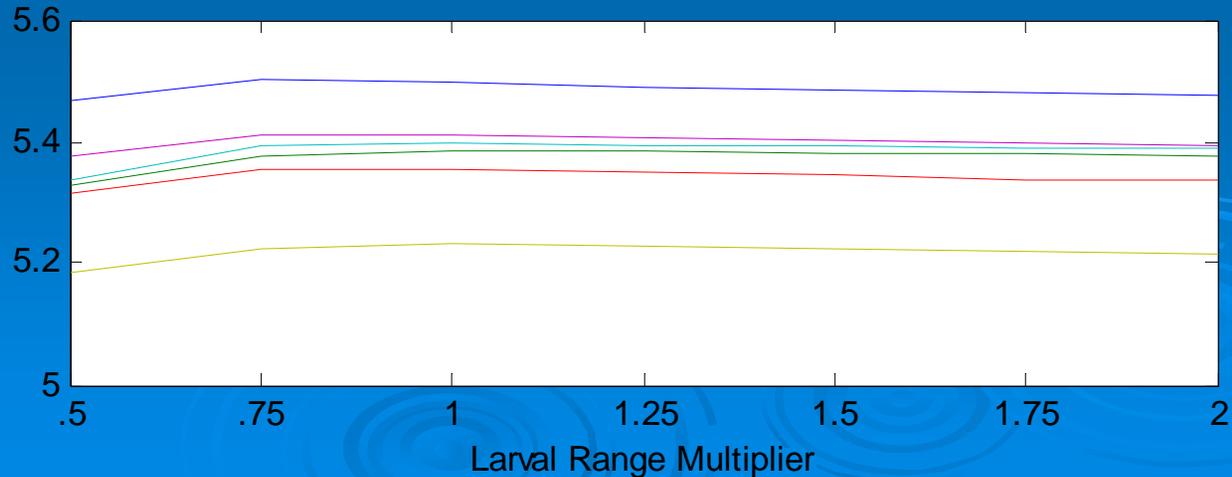
Sensitivity to Larval Dispersal Distance (F=.05)

Composite Biomass (E=.05)

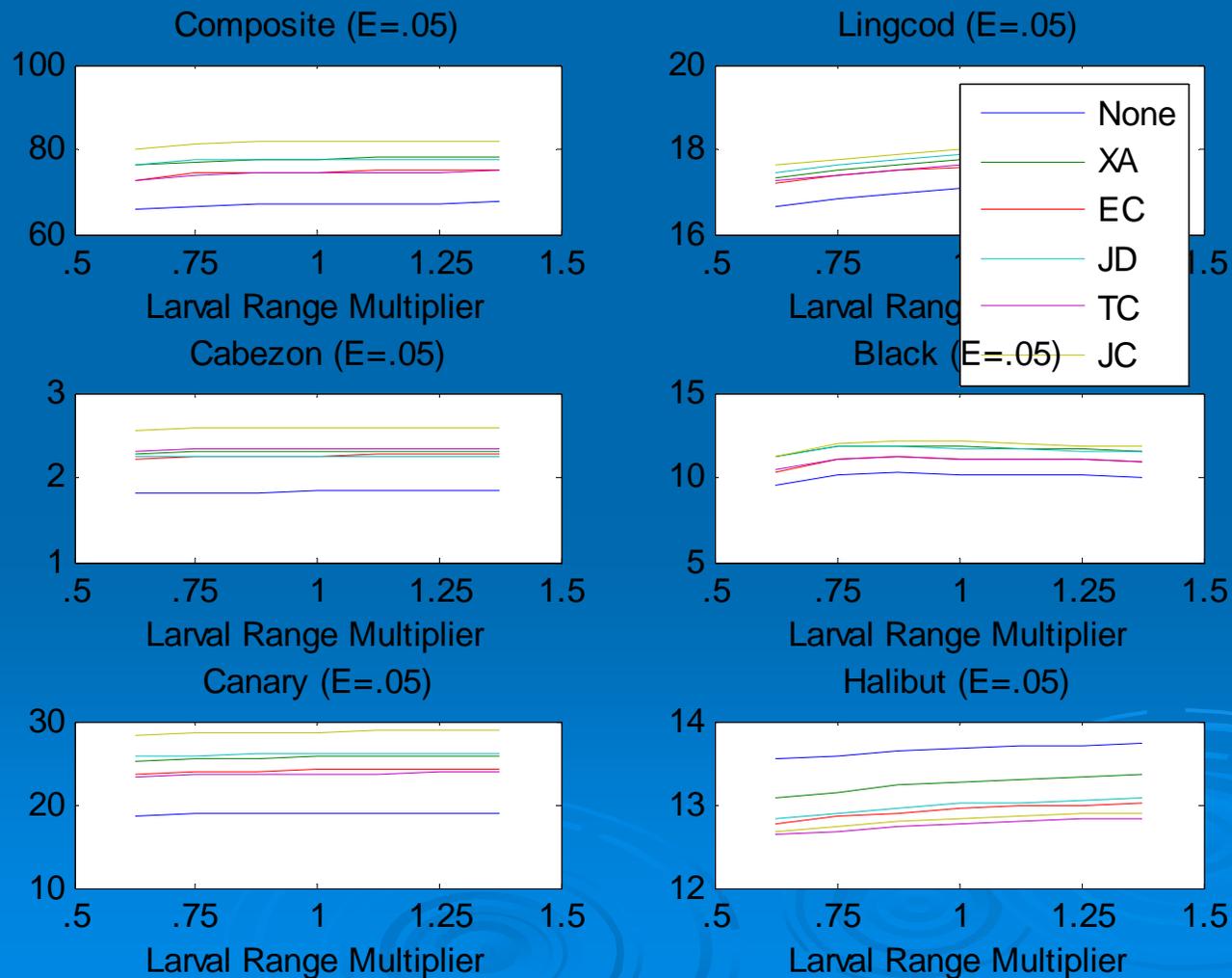


Ranking of policies for biomass is insensitive to Larval Range Multiplier

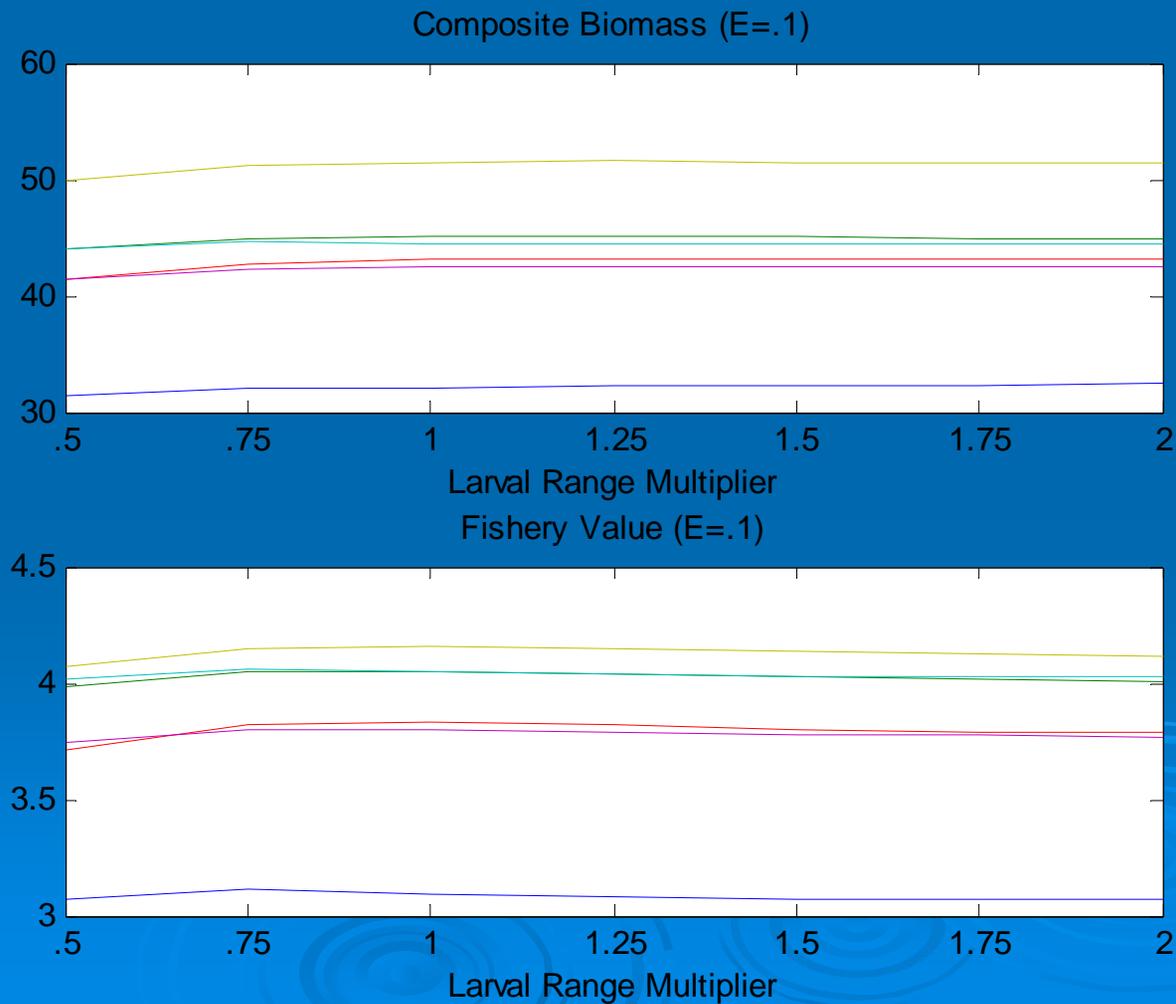
Fishery Value (E=.05)



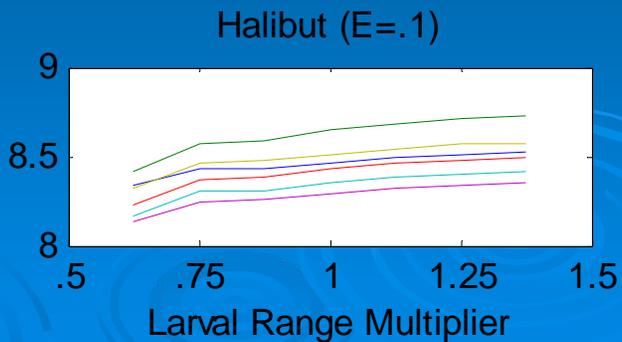
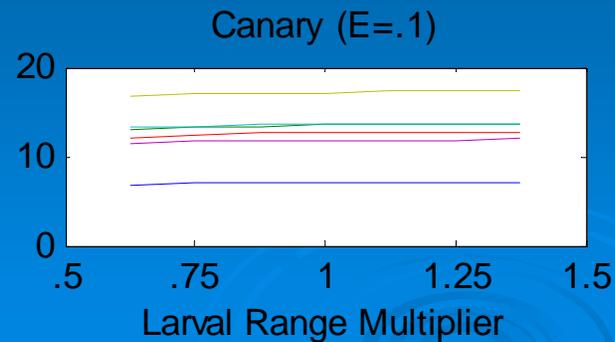
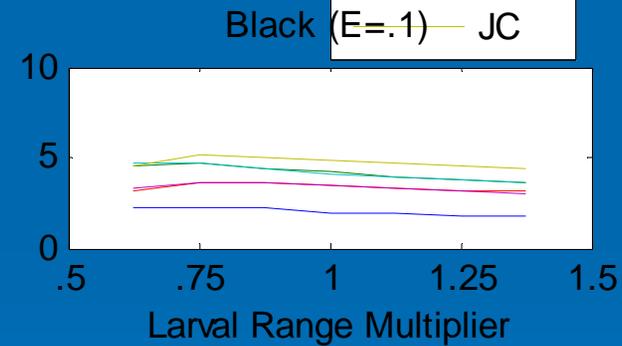
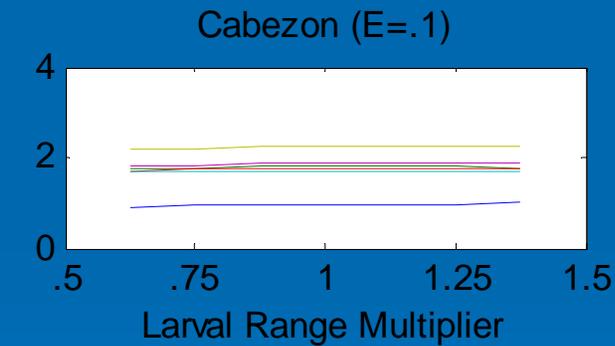
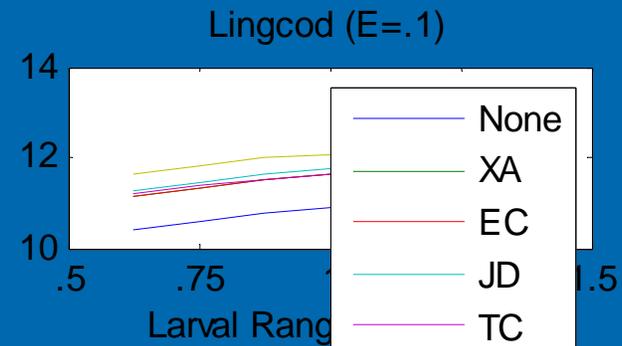
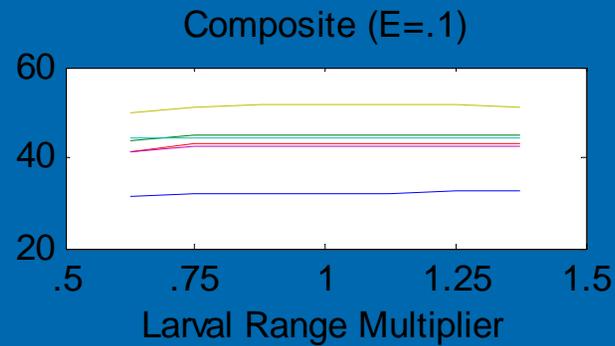
Larval, species-by-species



Sensitivity to Larval Dispersal ($F=.1$)

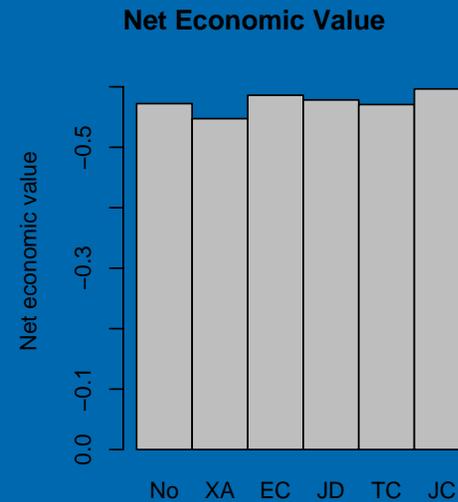
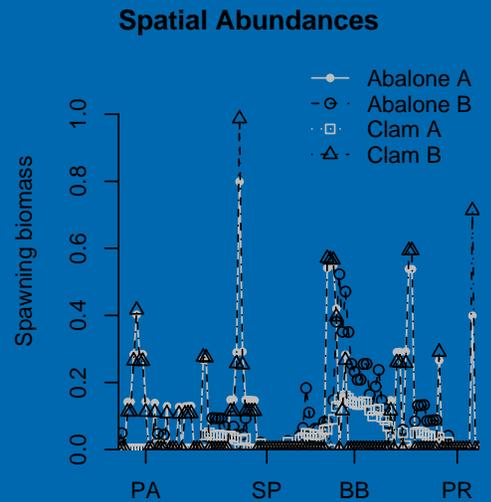


Larval, species-by-species

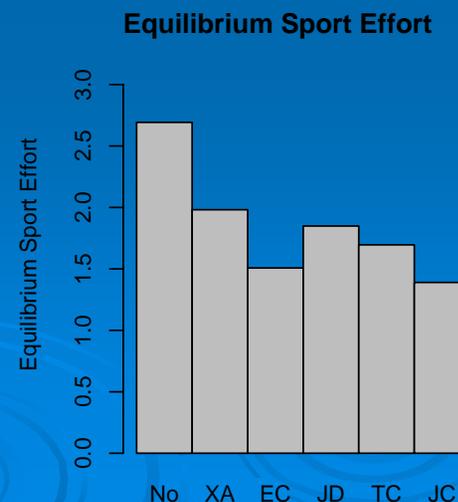
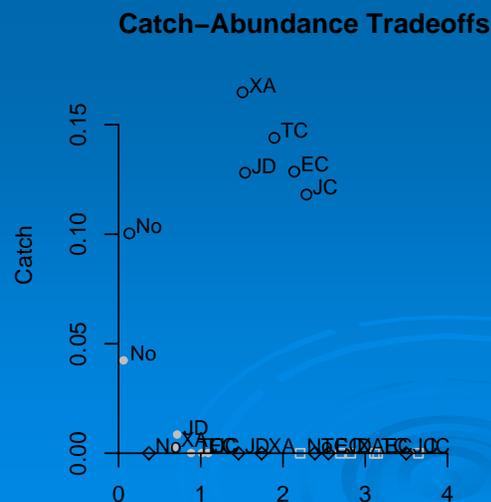


Invertebrates – Management Fails

ABALONE HIGH (BIONOMIC EQUILIBRIUM) FUTURE EFFORT SCENARIO



Short dispersers may not increase economic value due to no spillover



Reserves increase biomass for short and long dispersers

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.