ABSI CAB
November 30th, 2022

Ed Camp
Fisheries and Aquatic Sciences, University of Florida

Outline of things to go over

1. Disclaimer/disambiguation
2. Simulation results: Review and updated harvest months
    -Take home points and questions
3. Simulation results: Uncertainty in closures
    -Take home points and questions
4. Simulation results: Uncertainty in shell dynamics
    -Take home points and questions
5. Simulation results: Annual restoration
    -Take home points and questions
1. Options for future modeling (not done yet)
    -Better scaling
    -Spatially explicit (multiple reefs)

1. Disclaimers and disambiguation

1. Disclaimers regarding models

1. Model results are draft—they will change

2. Models shown today are more useful for comparing (across assumptions and strategies) than for predicting absolute values

3. There is massive uncertainty in what I'm showing. There is some evidence for depensation but we don't know what drives it. These results assume it is driven by habitat. If that is incorrect, most of these results (wrt restoration) will be useful

1. Disambiguation re: “models”

- Multiple different modeling work I’m doing
  - Stock assessment models—estimating parms
    - Initially traditional fisheries (i.e. no shell dynamics explicit, subsumed with recruitment anomalies)
    - Extended to (try to) estimate shell dynamics (2-stage estimation, not ideal but necessary)
  - Simulation models— “what if” analysis
    - Detailed shell dynamics, but how to inform?
    - Best guesses (lit, data)
    - Inform from newer assessment models
    - *Today you will see simulation models that have been informed by stock assessment models. More formally statistically fit models in future.*
  - Other projects too, not talking about them today

2. Simulation results: Review and updated harvest months

1. Disclaimer/disambiguation
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    - -Take home points and questions
3. Simulation results: Uncertainty in closures
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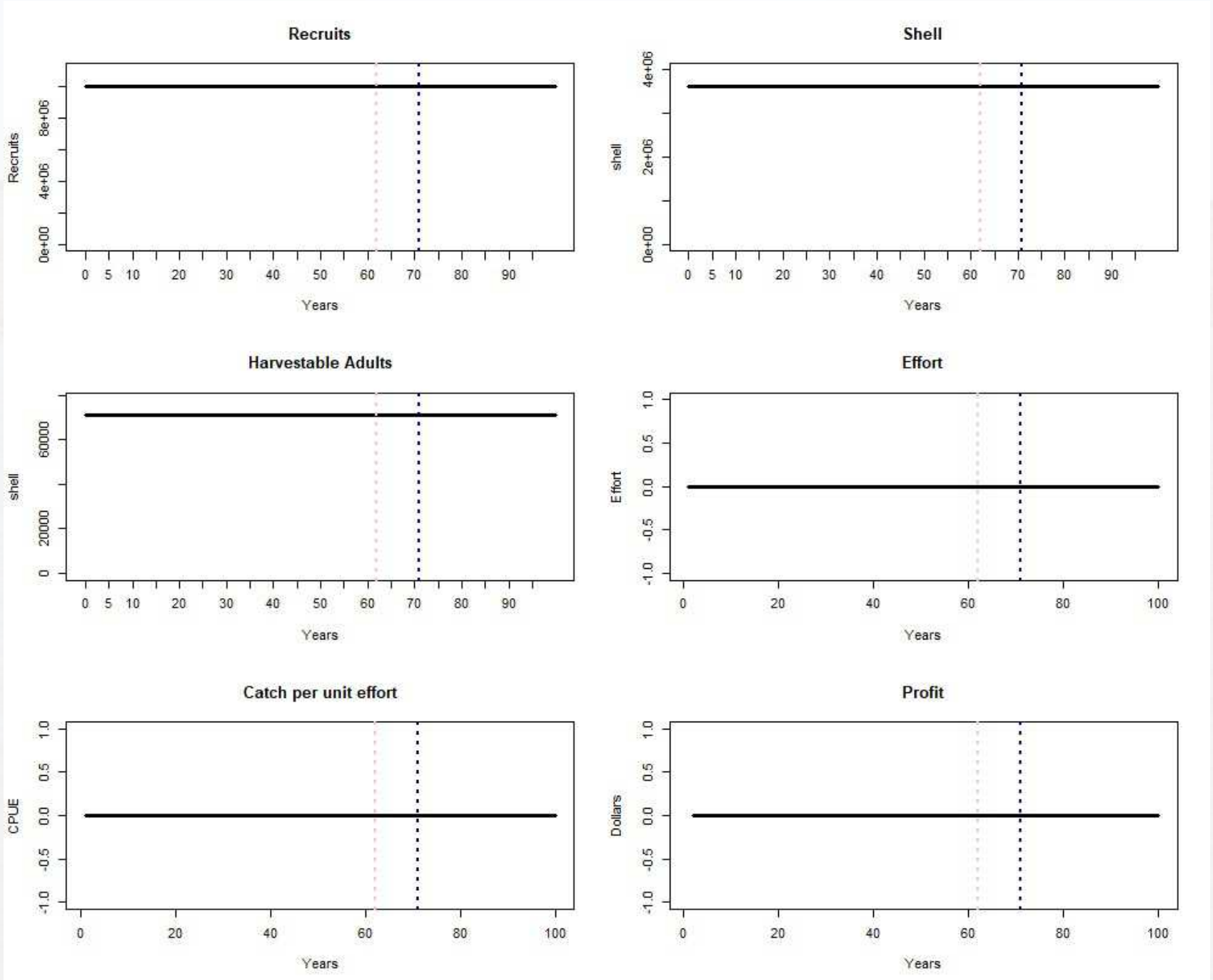
2. Simulation results: Review and updated harvest months

- Last time I showed figure assuming harvest in every month except August and September, based on landings.
- Changed to now harvest every month except June, July, and August
- Some affect on model—basically harvesting one less month means it would take more effort to collapse population.

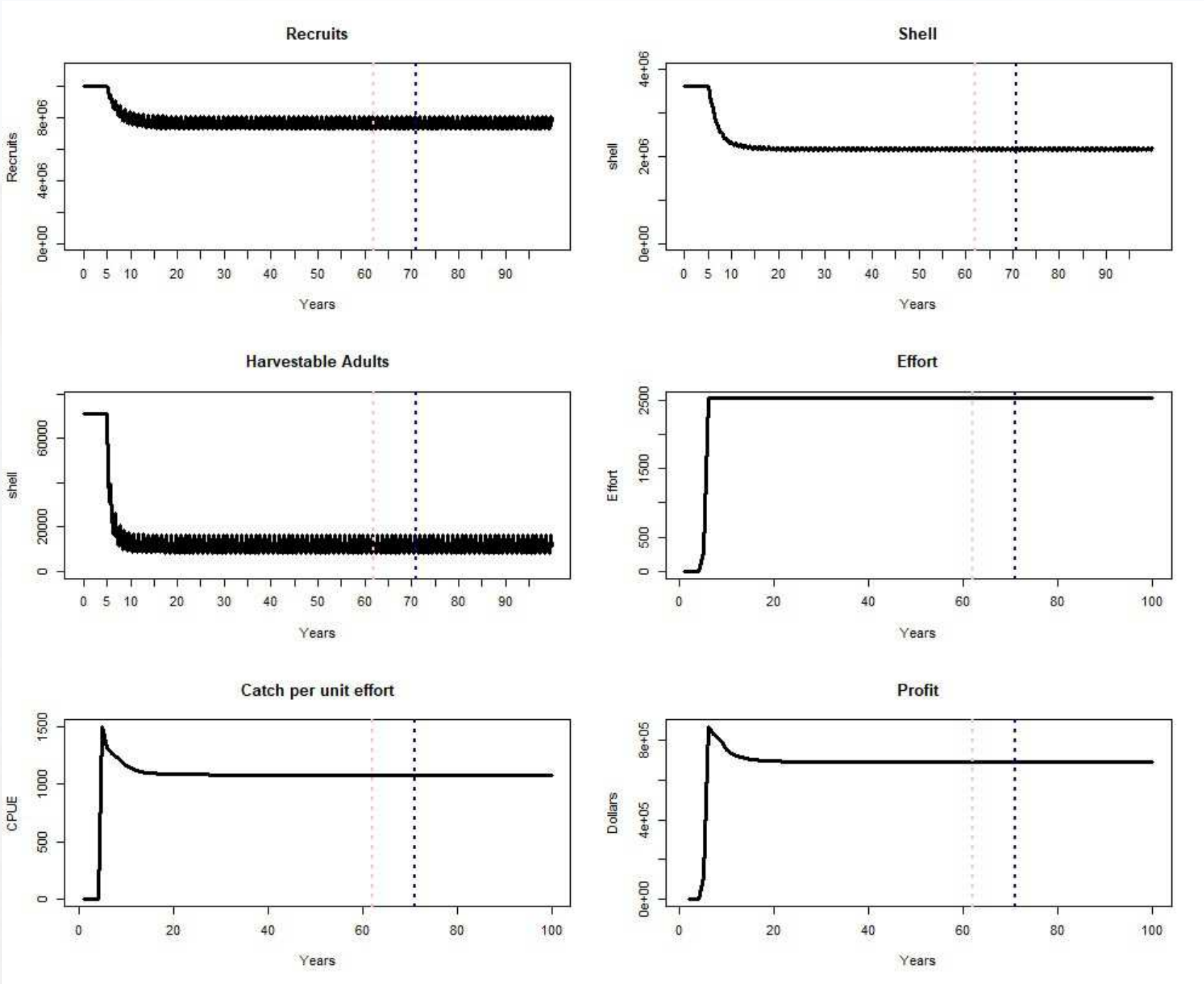
- Also updated assumption of effort post collapse, pre-restoration. It was 0, I now assume 0.1.

- Both of these are small changes

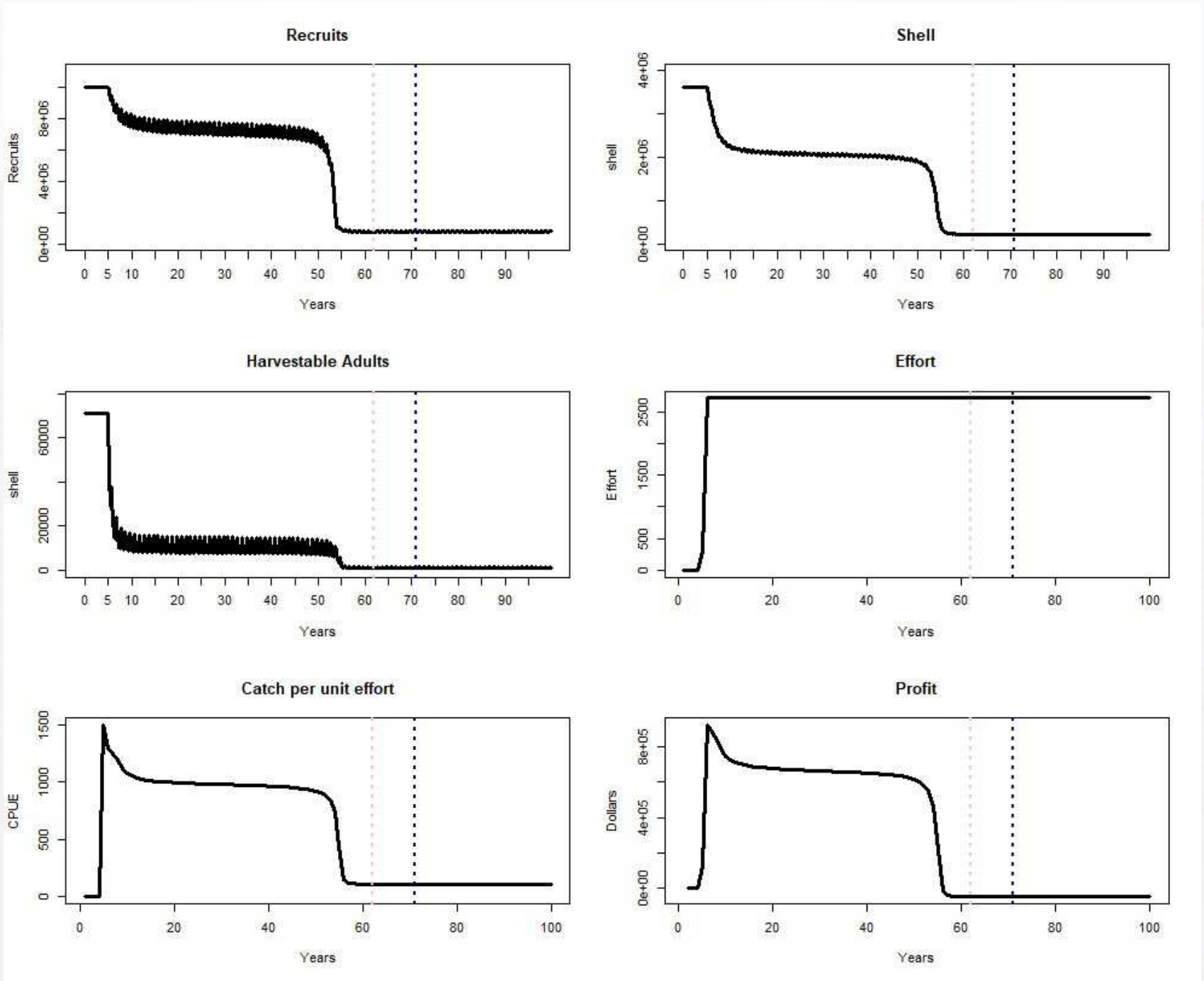
2.1 Null model, no fishing



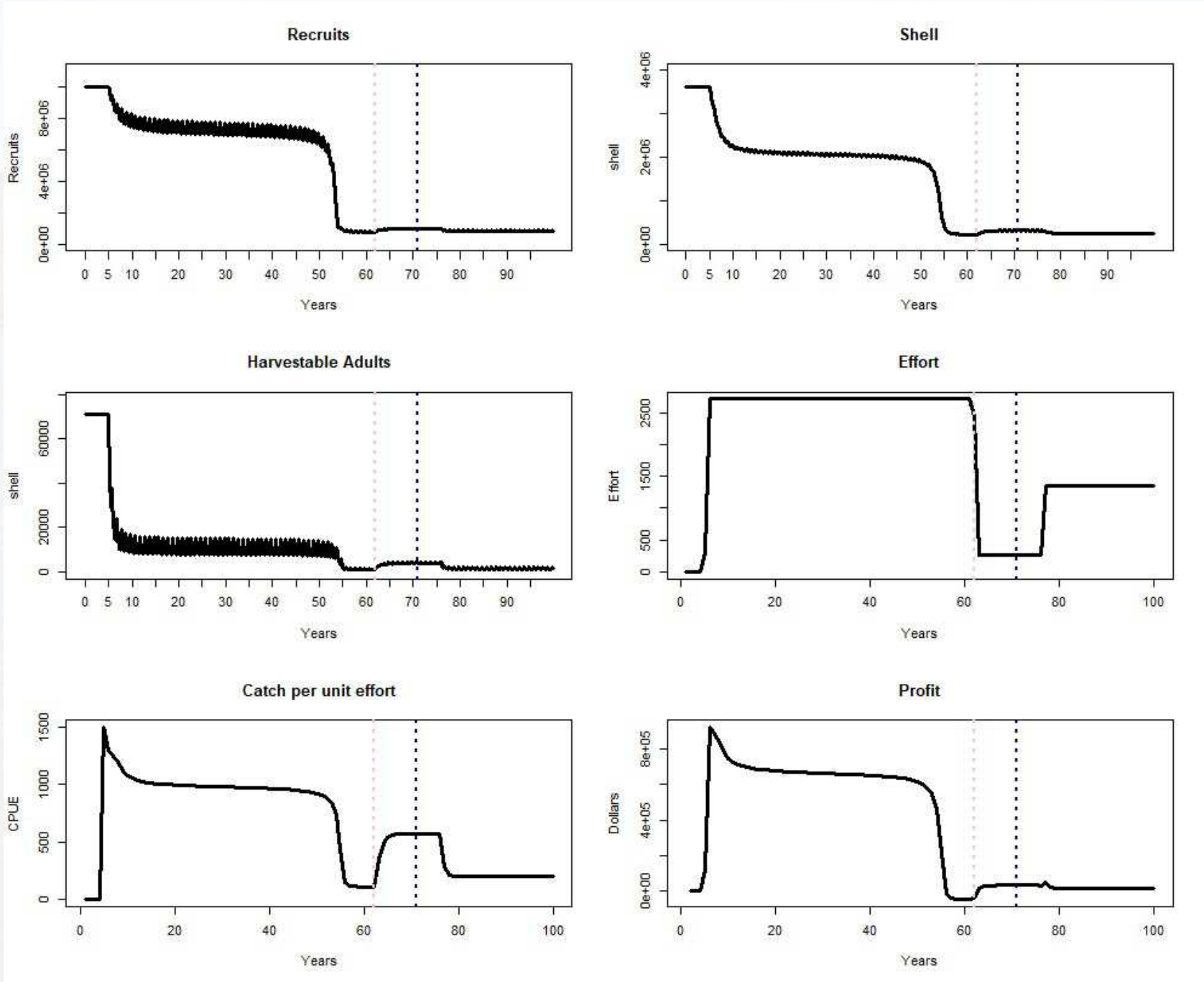
2.2 Fishing, but no “collapse”…yet



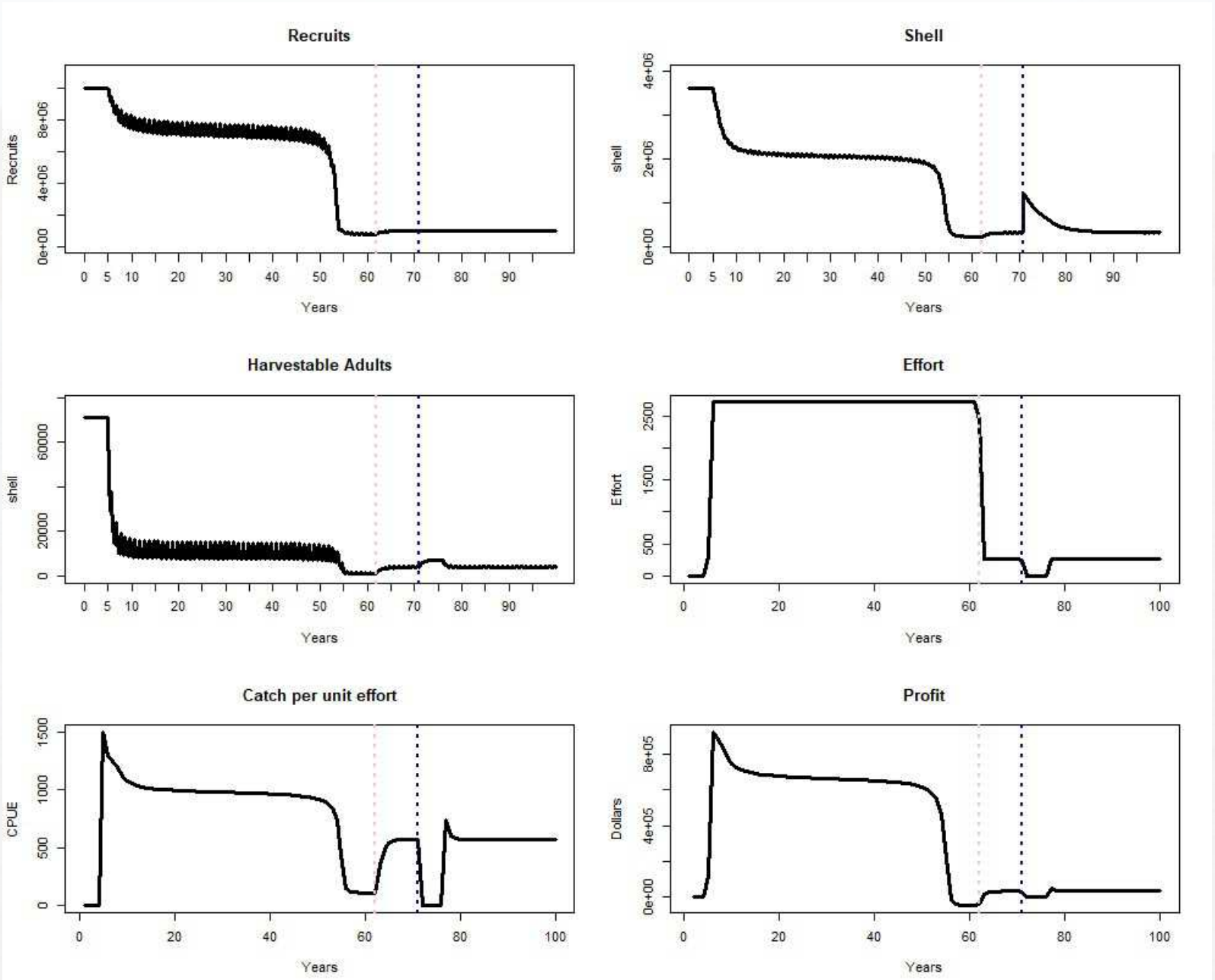
2.3 More effort, collapse



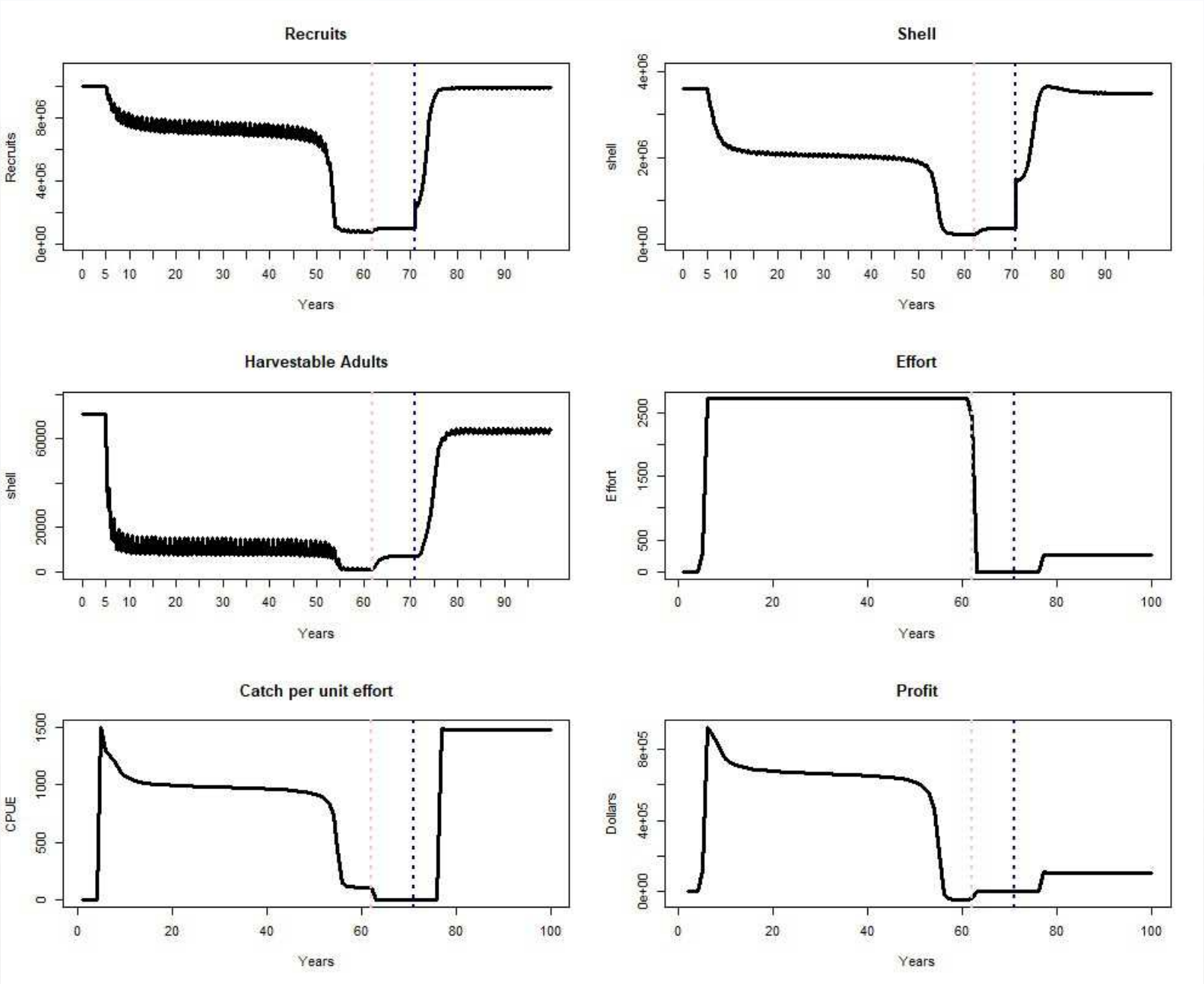
2.4 More effort, collapse, effort reduction



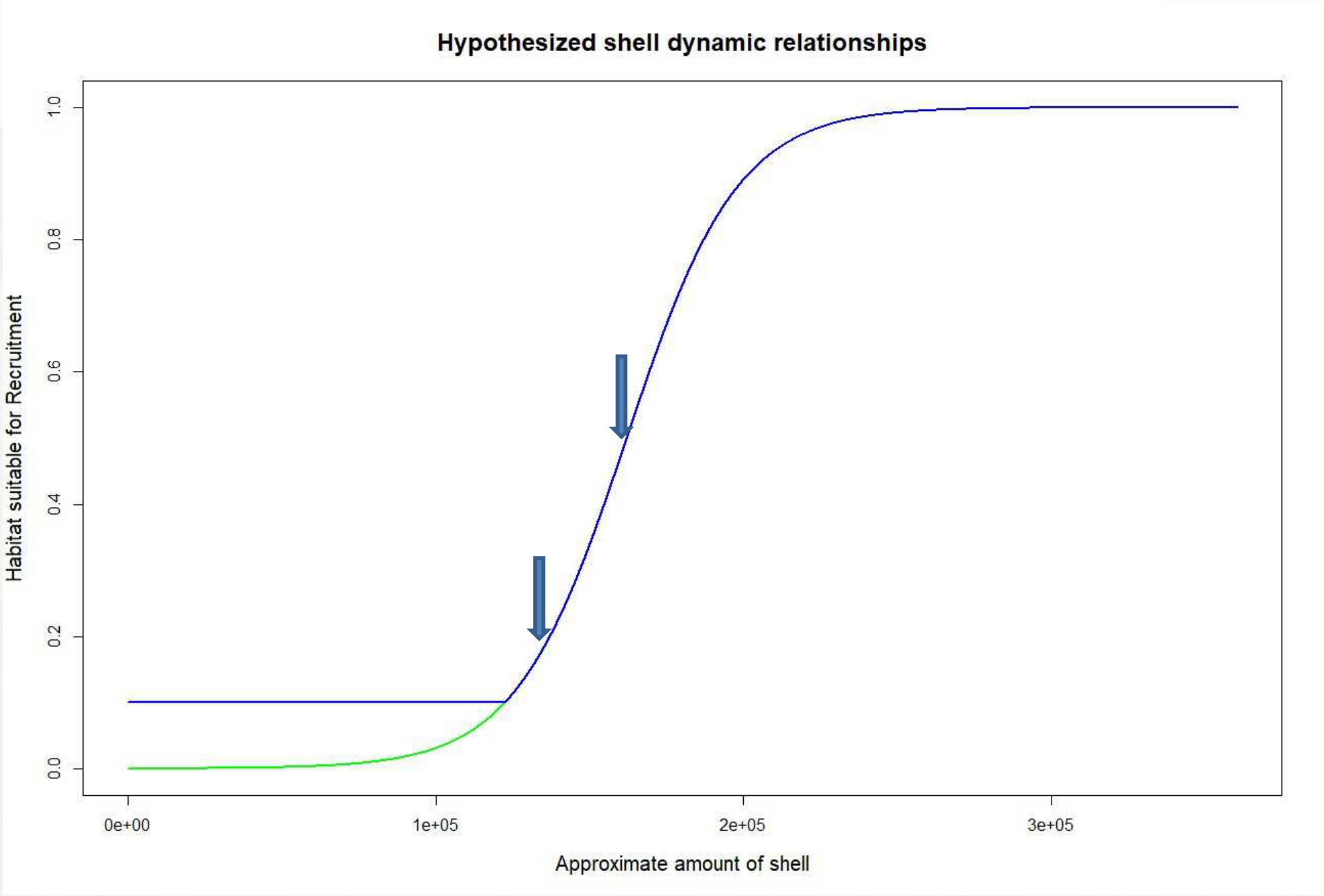
2.4 Eff. Reduction, 5yr closure, major restoration 25% initial shell), post-restoration effort 10% original



2.5 Eff. Reduction, 5yr closure, major restoration (33% shell init), post-restoration effort 10% original



2. Shell dynamic oyster simulations



2. Caveats and notes on this

- 1. That relationship between shell and habitat suitable for recruitment is critical, and very uncertain.
  - Hard to estimate (statistically tricky)
  - No near-unfished data
  - No measurements quantifying habitat change, only anecdotal

- 2. Relationship uncertain in 2 ways
  - How “sharp” it is (affecting suddenness of success/failure)
  - Where inflection point is (here probably too conservative, why I did that)

- 3. A much greater uncertainty looms—is it even habitat that matters?
  - Other things besides habitat can drive low survival (preds, disease, env)
  - Sometimes one thing changes a system and another sustains that change (cod)
  - Habitat is almost certainly *a* driver, doesn’t mean it’s the only one
  - Note habitat and preds can be linked, that is expected
  - See Johnson et al. 2022 for more detail on this

2. Affect of small changes

- Basically if we assume there was/will be no fishing in 3 months (what you just saw) instead of 2 (what you saw last time), it will take more effort to collapse

- And if we assume that the post-collapse, pre-restore effort was 10% of original, instead of 0%, we have to restore a tad more (33% initial shell instead of 32%).

- Basically, I'm just balancing things to show a collapse (because we think we saw one) and a potential recovery (because we'd like to believe that's possible).

- Patterns don't change with change in closed months.

2. Suggested take-home points

- **If believe assumptions, very possible to do a lot of restoration and not enough to bring back system**
  - Even with carefully controlled/managed effort
  - Asymmetrical risk—much better to restore too much than too little

Likely critical amount or types of restoration, but we are not sure what they are

2. Discussion and questions (so far)

2. Simulation results: Review and updated harvest months

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1. Options for future modeling (not done yet)
    -Better scaling
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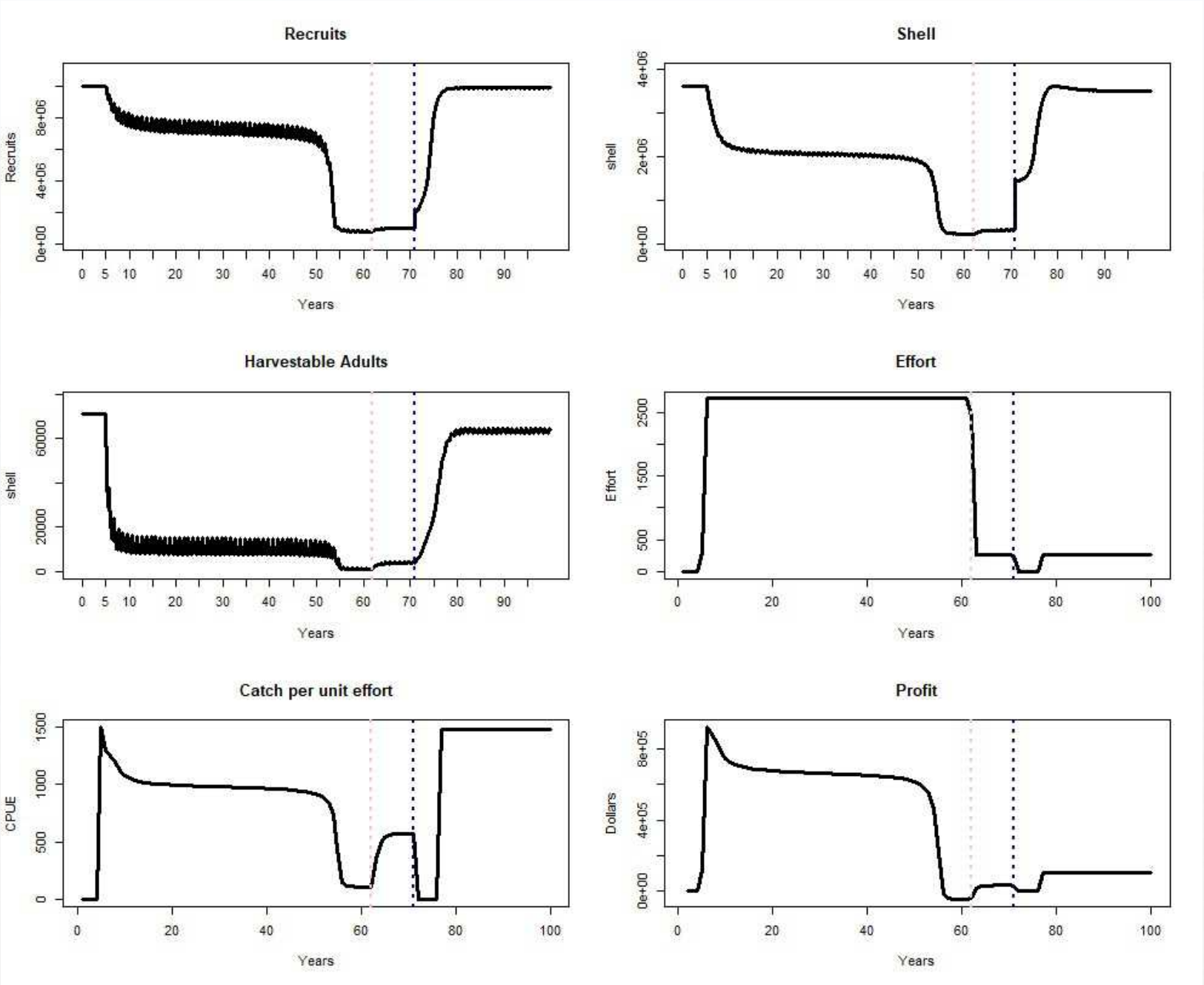
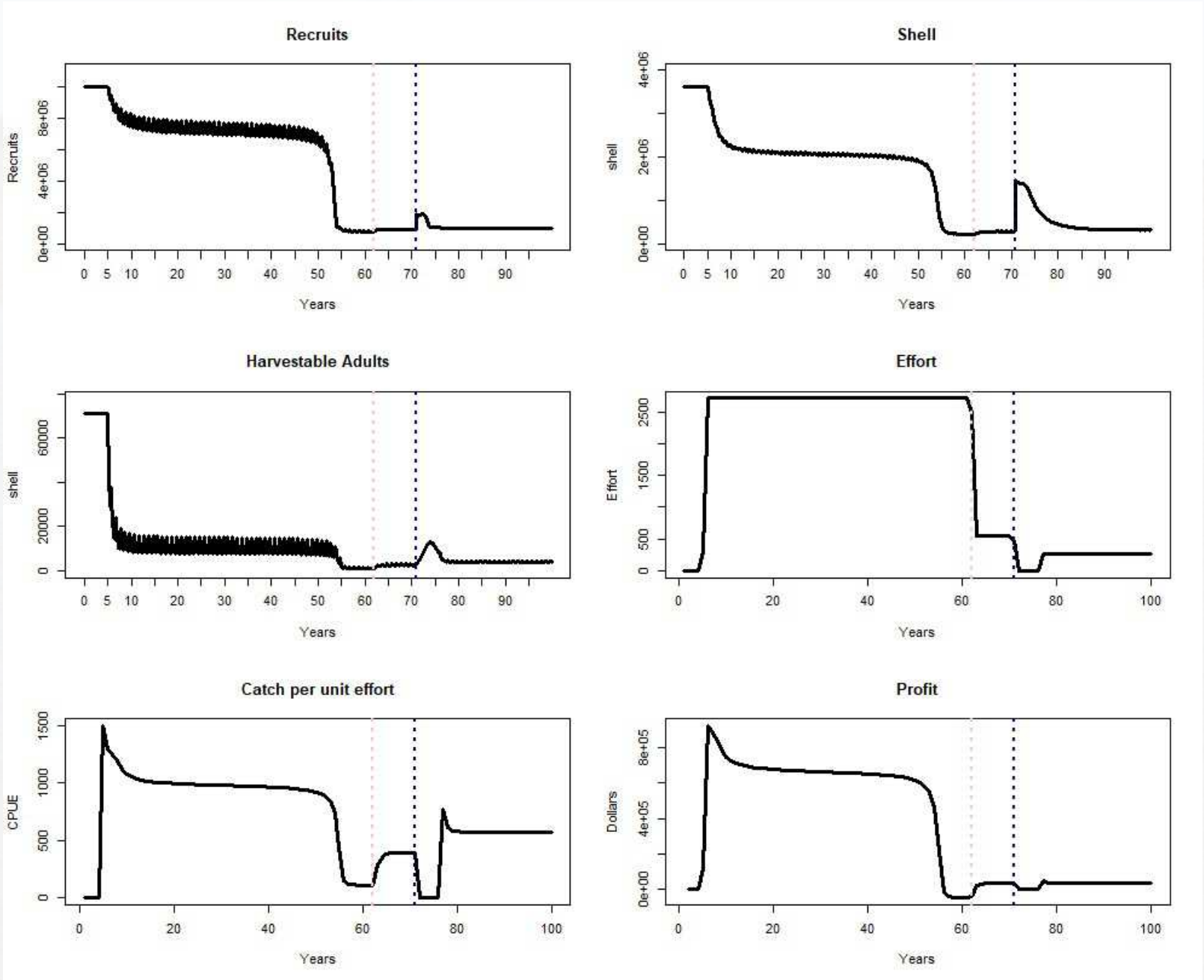
3. Simulation results: Uncertainty in closures

- A number of different “knobs” involved here
  - How much of a decrease in effort happens after collapse and before restoration
  - Is there a closure after restoration, and if so for how long

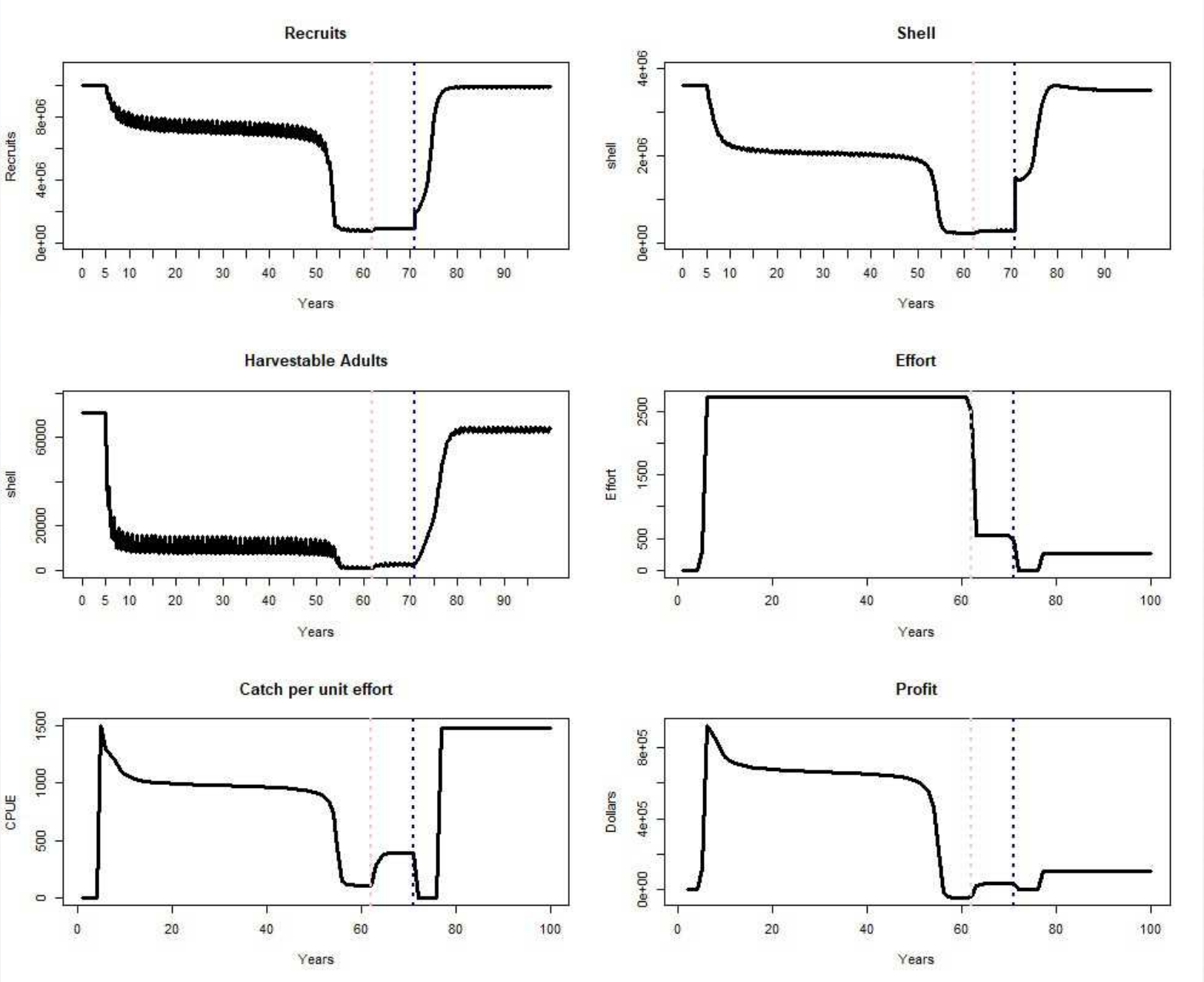
3.1 Uncertainty in closures—baseline—10% post-collapse effort, 0 effort for 5 years following restoration (33%)



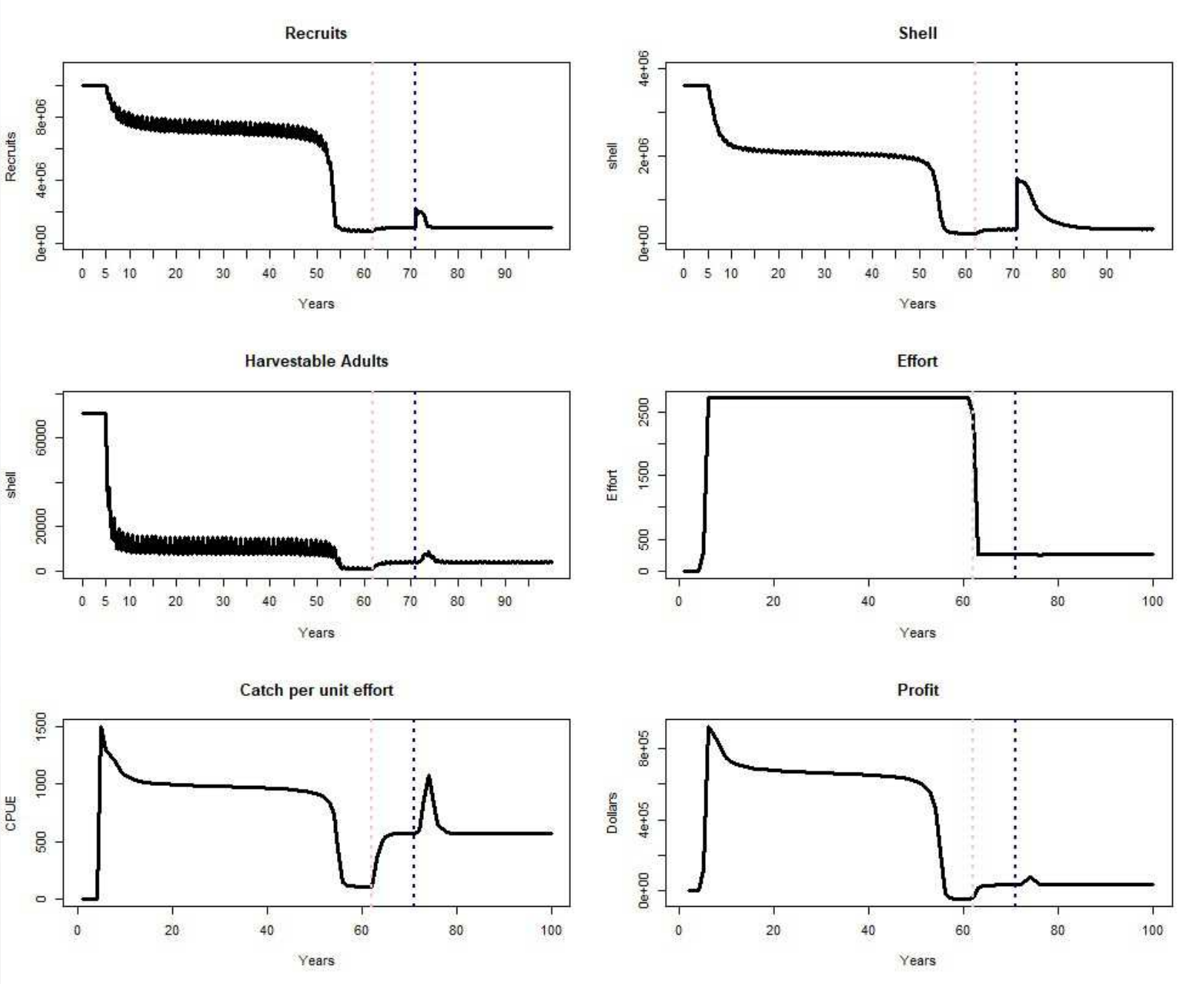
3.2 Uncertainty in closures—20% post-collapse effort, 0 effort for 5 years following restoration (33%)



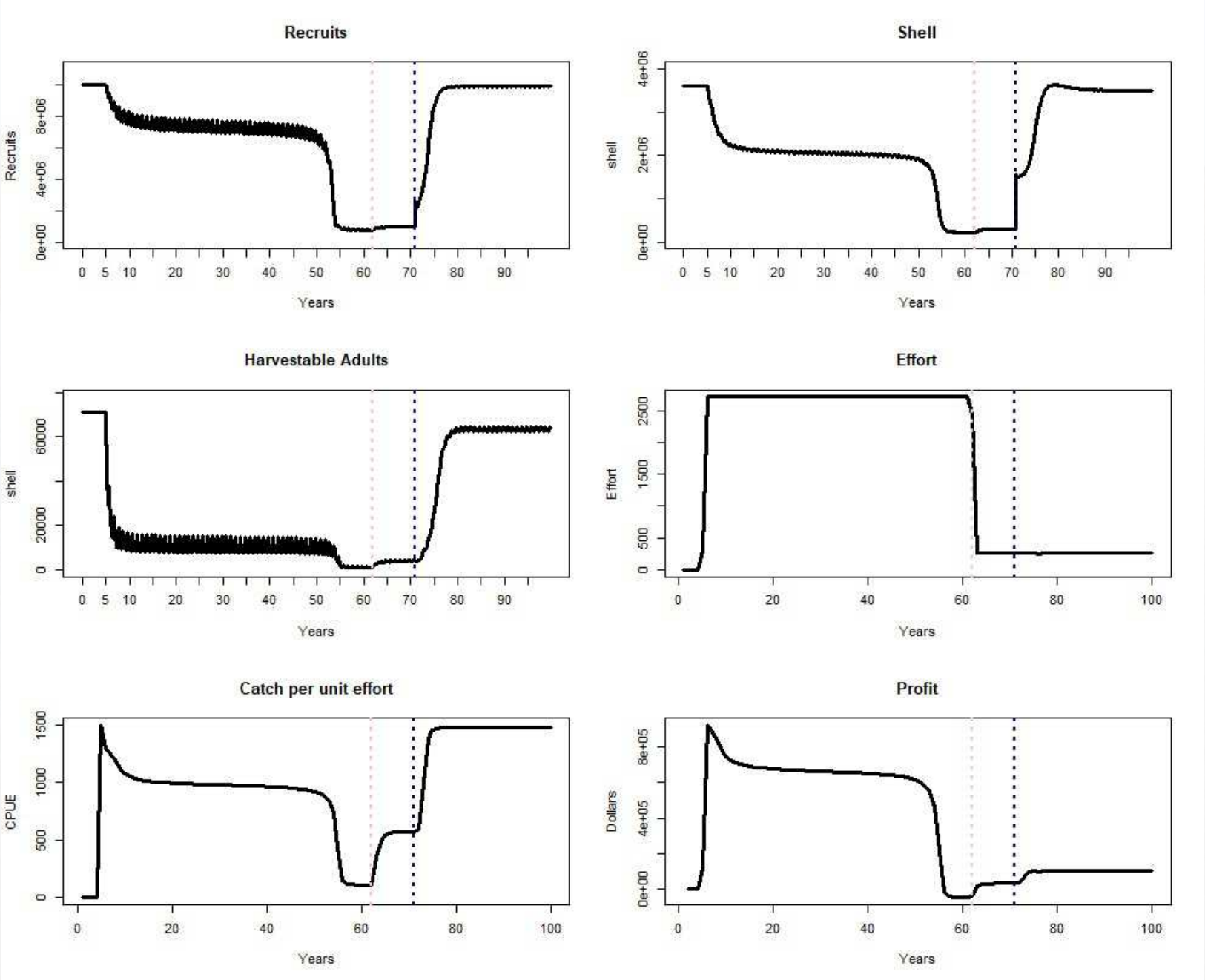
3.3 Uncertainty in closures—20% post-collapse effort, 0 effort for 5 years following restoration (34%)



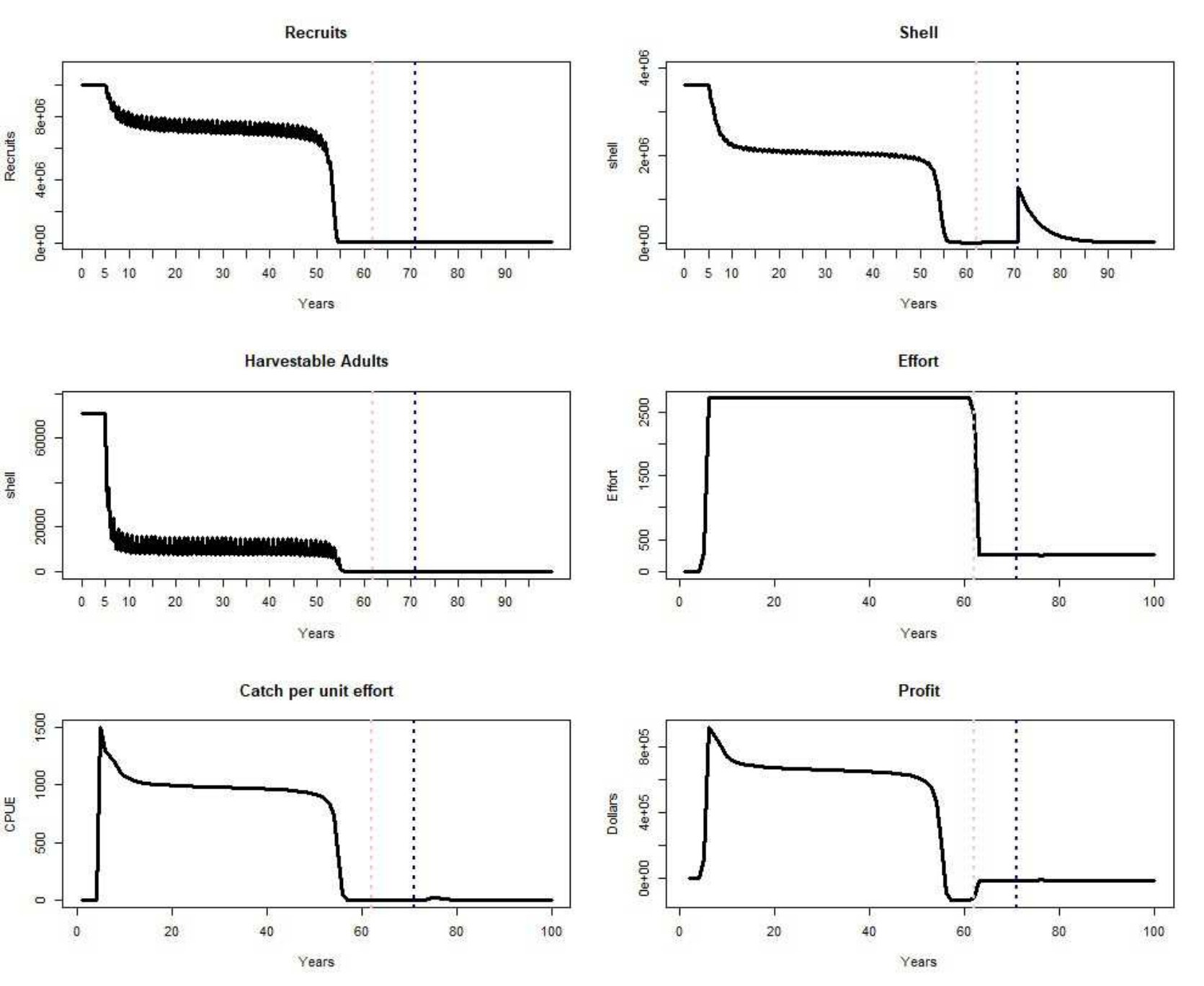
3.4 Uncertainty in closures—10% post-collapse effort, 10% effort for 5 years following restoration (33%)



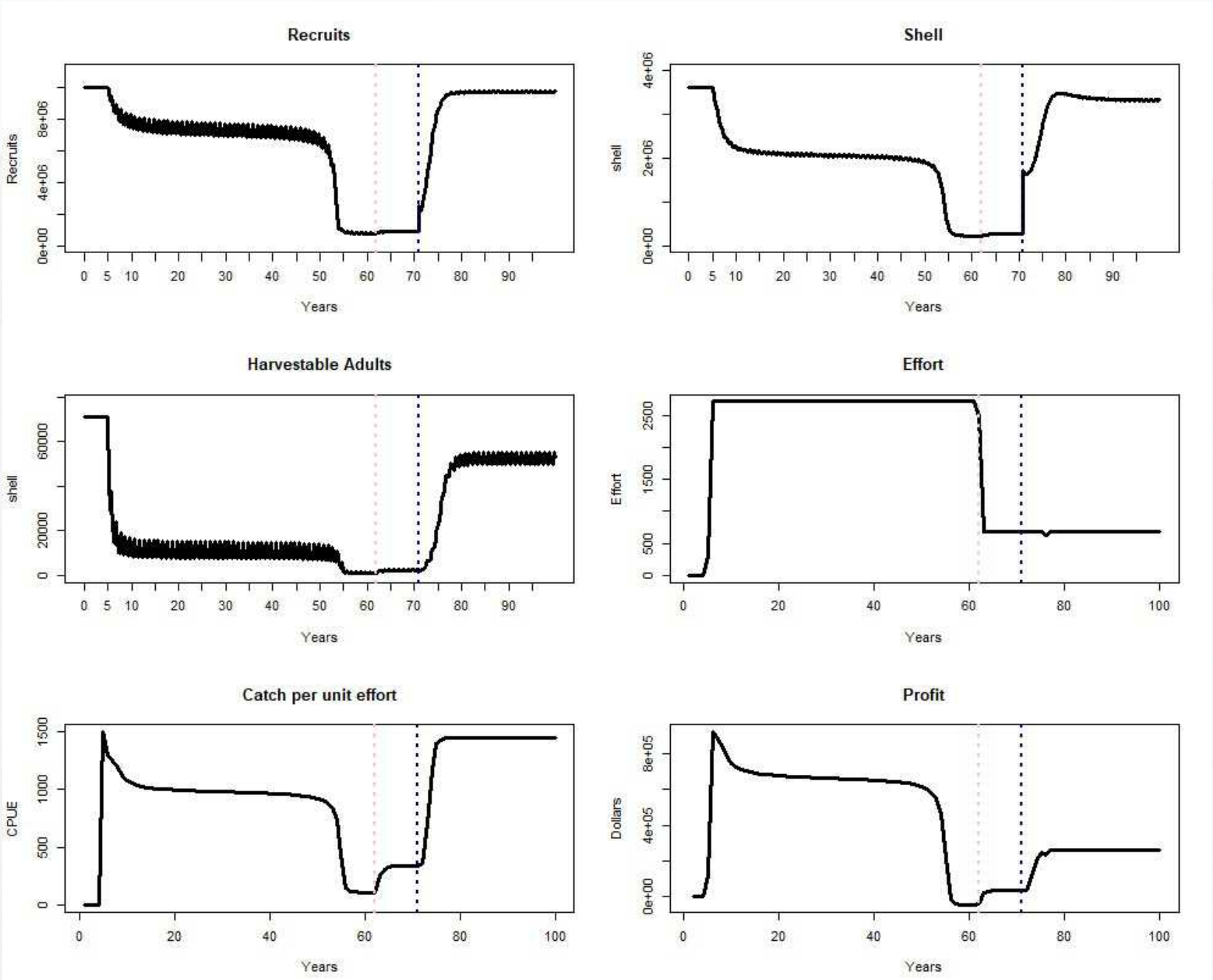
3.5 Uncertainty in closures—10% post-collapse effort, 10% effort for 5 years following restoration (35%)



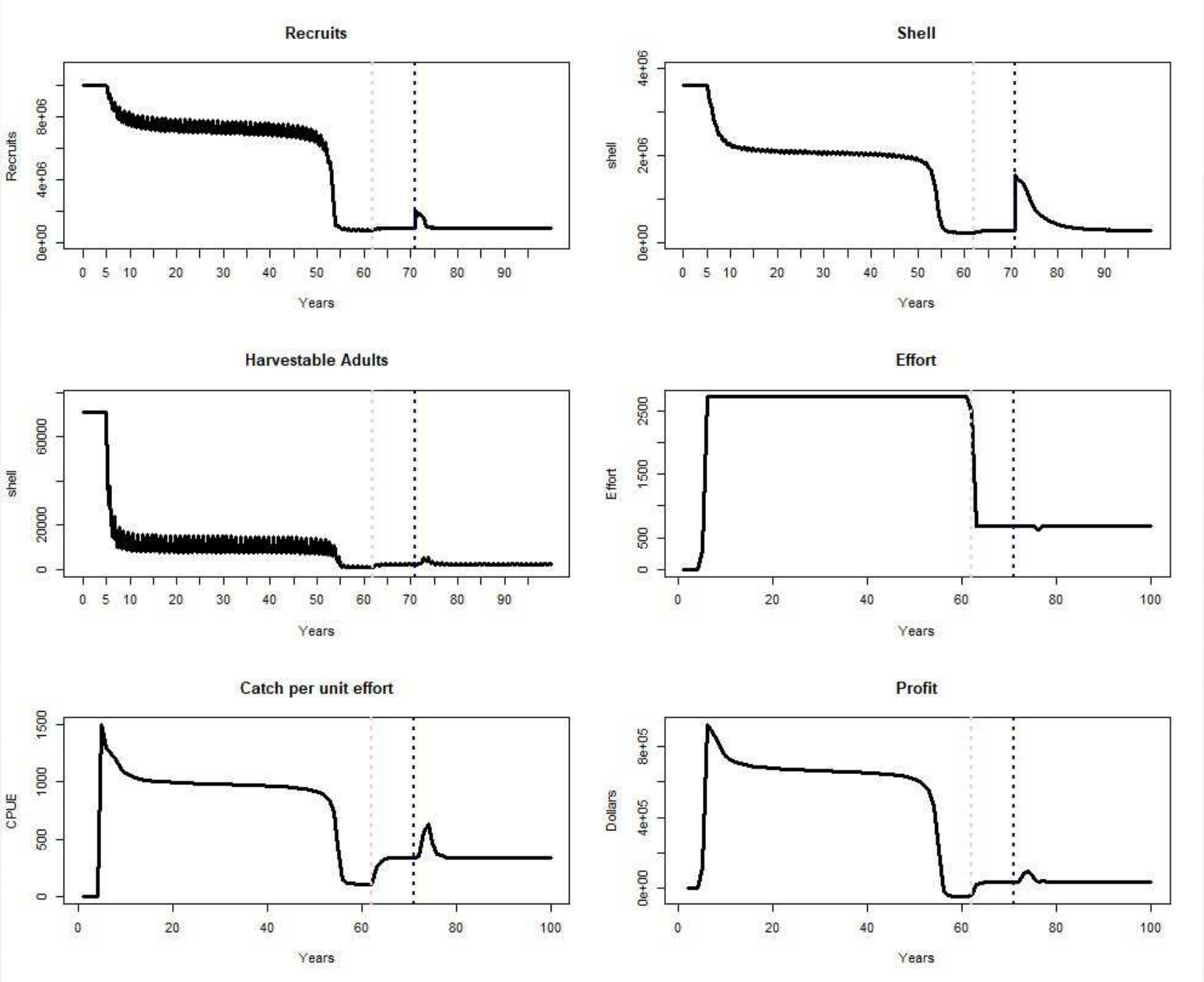
3.6 Same as previous but without “threshSafe”



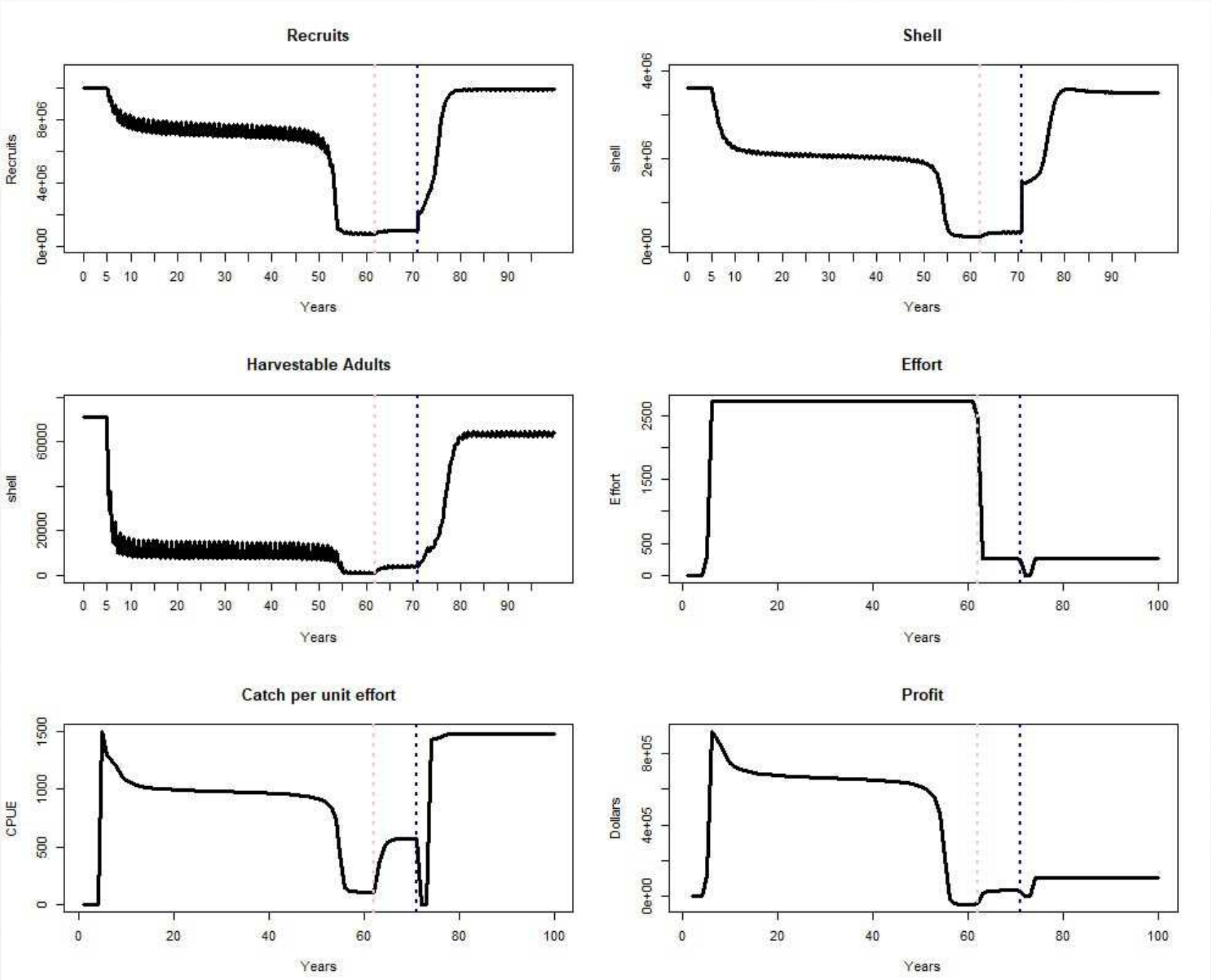
3.7 Uncertainty in closures—25% post-collapse effort, 25% effort for 5 years following restoration (40%)



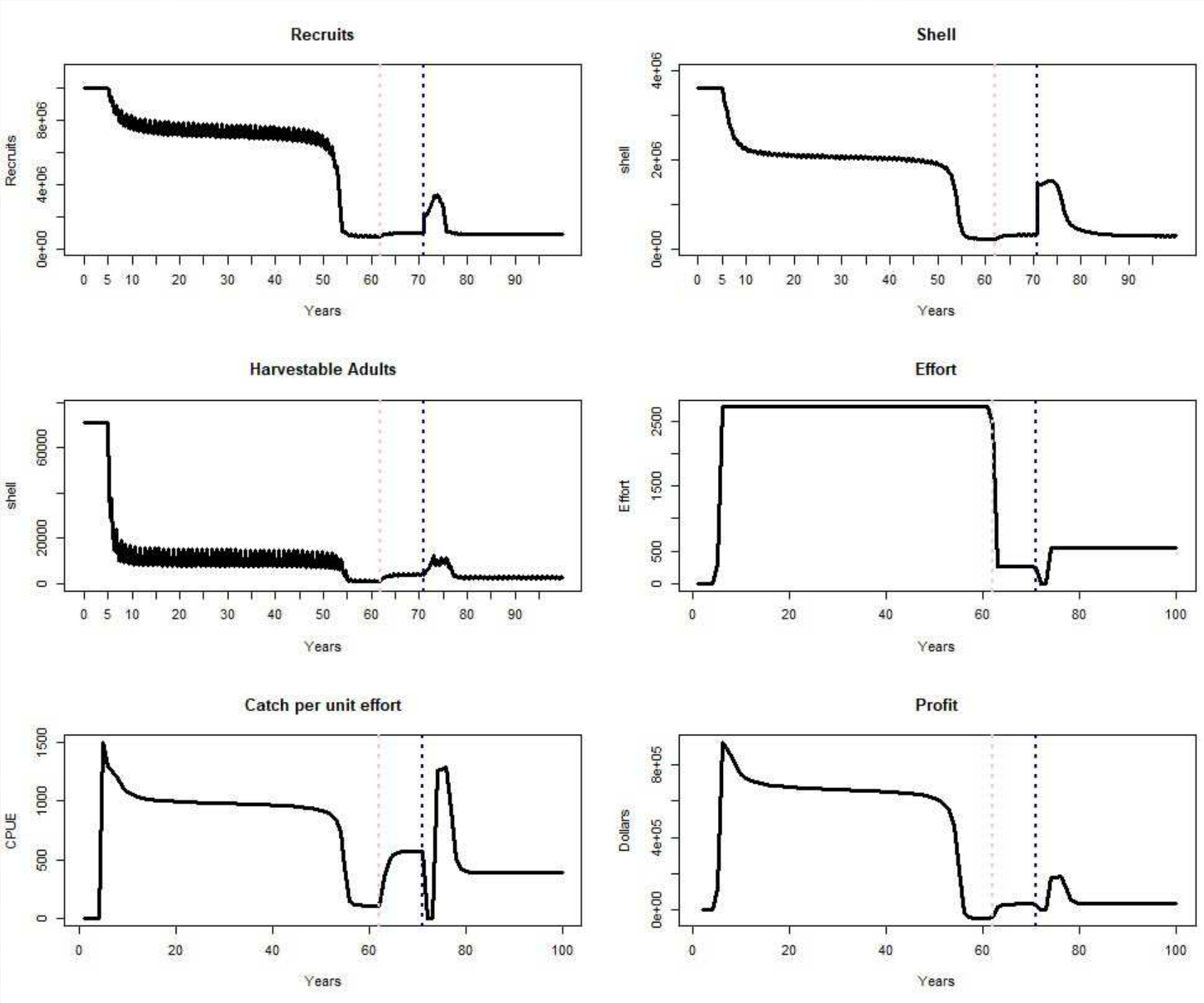
3.8 Uncertainty in closures—25% post-collapse effort, 25% effort for 5 years following restoration (35%)



3.9 Only a 2 year closure



3.10 Only a 2 year closure, but increase effort after recovery



3. Caveats and notes

- All this assumes it's habitat that's the issue—same as before, if this is wrong, these results won't hold
- We are assuming a "threshSafe" scenario in which that habitat can't get down to zero, which would cause local extirpation. That may be too optimistic an assumption.
- We are assuming we *can control fishing effort* even when populations come back strong. If we can't (either enforcement is lacking or public/political support isn't sufficient), these results will not hold

3. Take-home points on uncertainty in closures

1. Sure, it is possible to fish after collapse, during restoration and have the fishery come back *according to our assumptions* but you'll need to restore more.

2. If we get the amount of restoration wrong, fishing could result is failure to recovery the fishery

3. We don't know really anything about the ratio of fishing-to-restoration, nor about the thresholds of how much restoration is needed

4. **This is why people have said simulations models can't tell us what we most need to know—they can't tell us the level of restoration we need. We can probably only learn that from actual large scale experimentation.**

3. Discussion and questions (so far)

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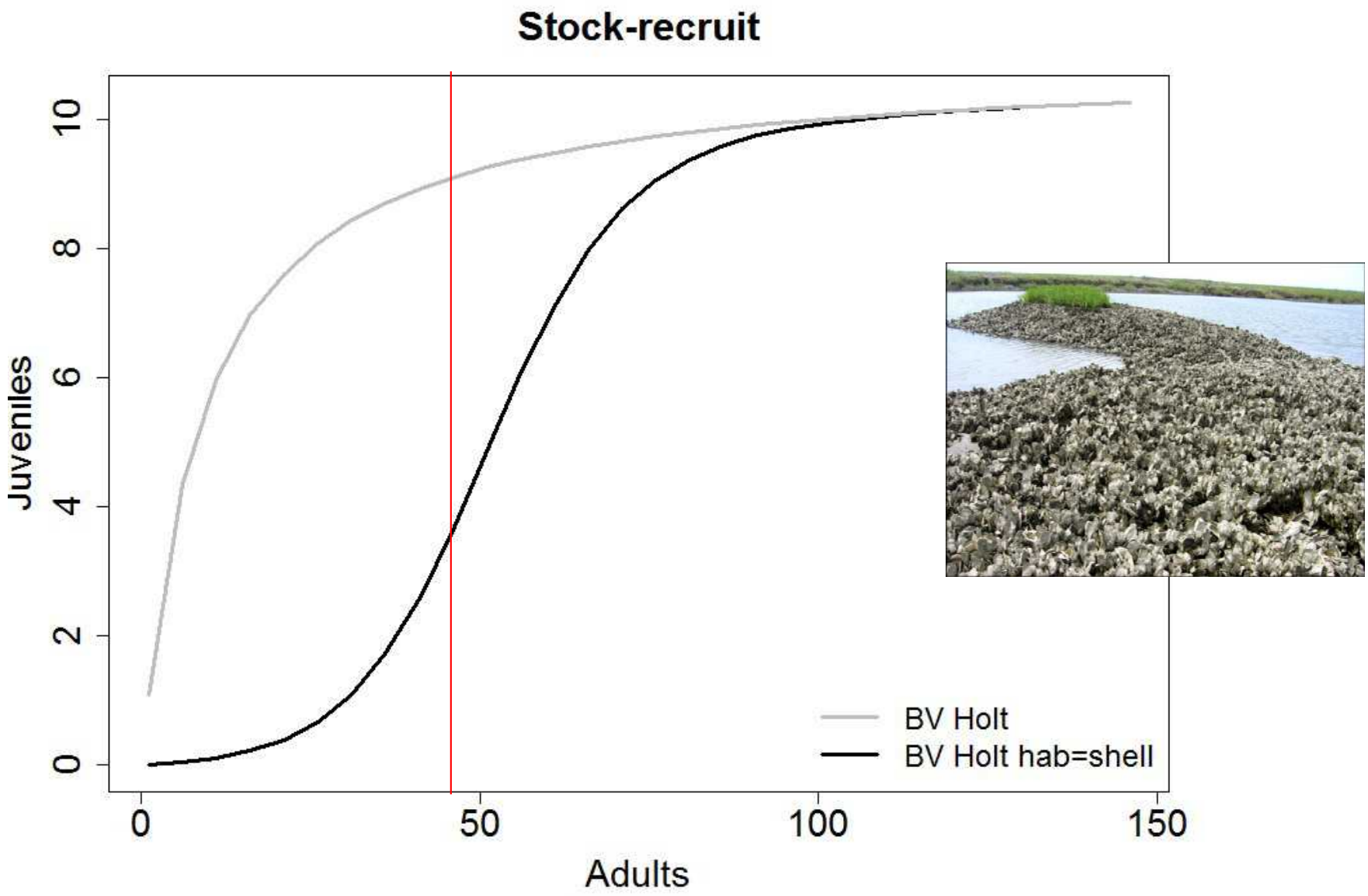
6. Options for future modeling (not done yet)
    -Better scaling
    -Spatially explicit (multiple reefs)

3. Simulation results: Uncertainty in closures

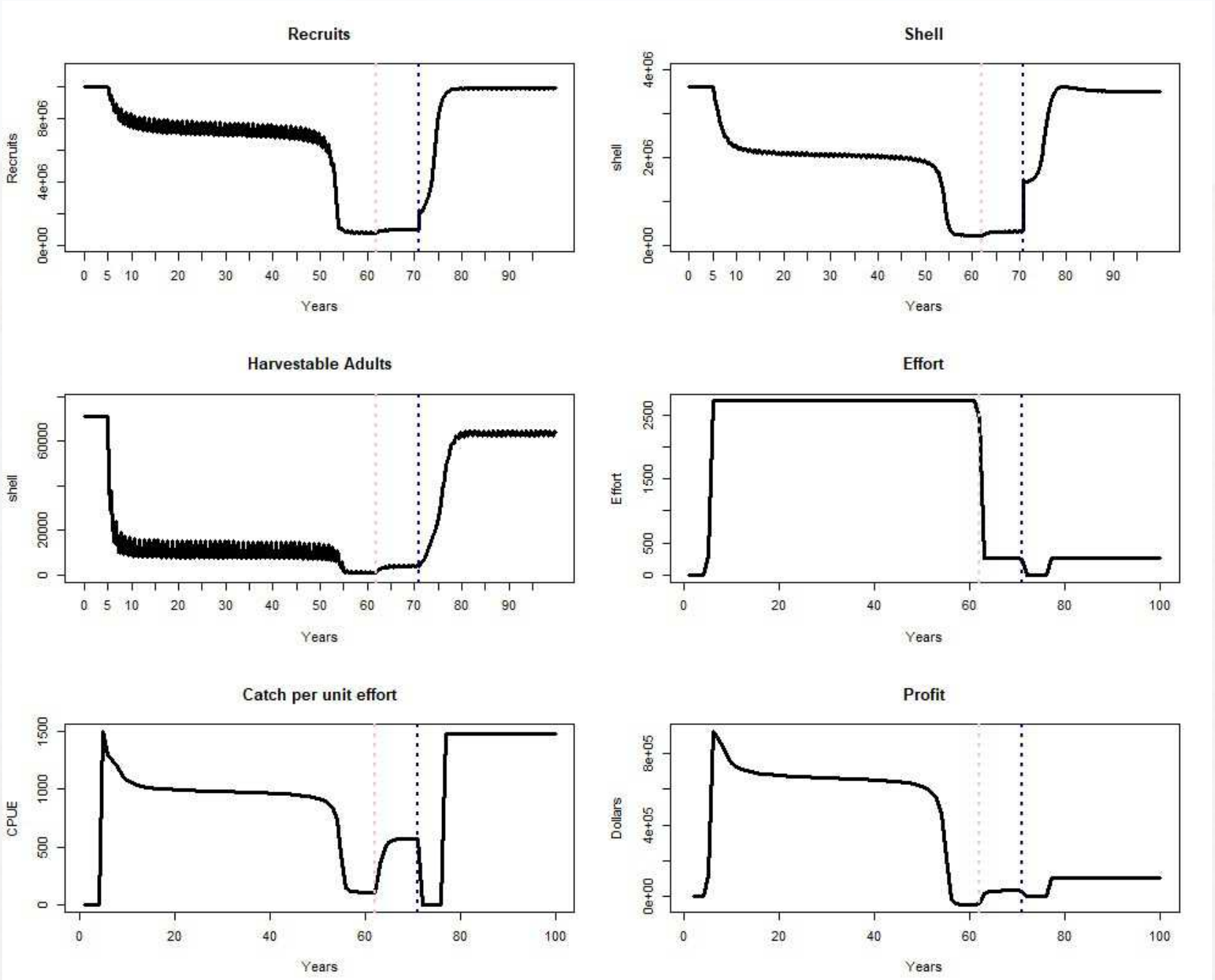
- Take a look at different assumptions about habitat-suitable-for-recruitment as a function of shell (+ restoration)

- Focus on inflection point

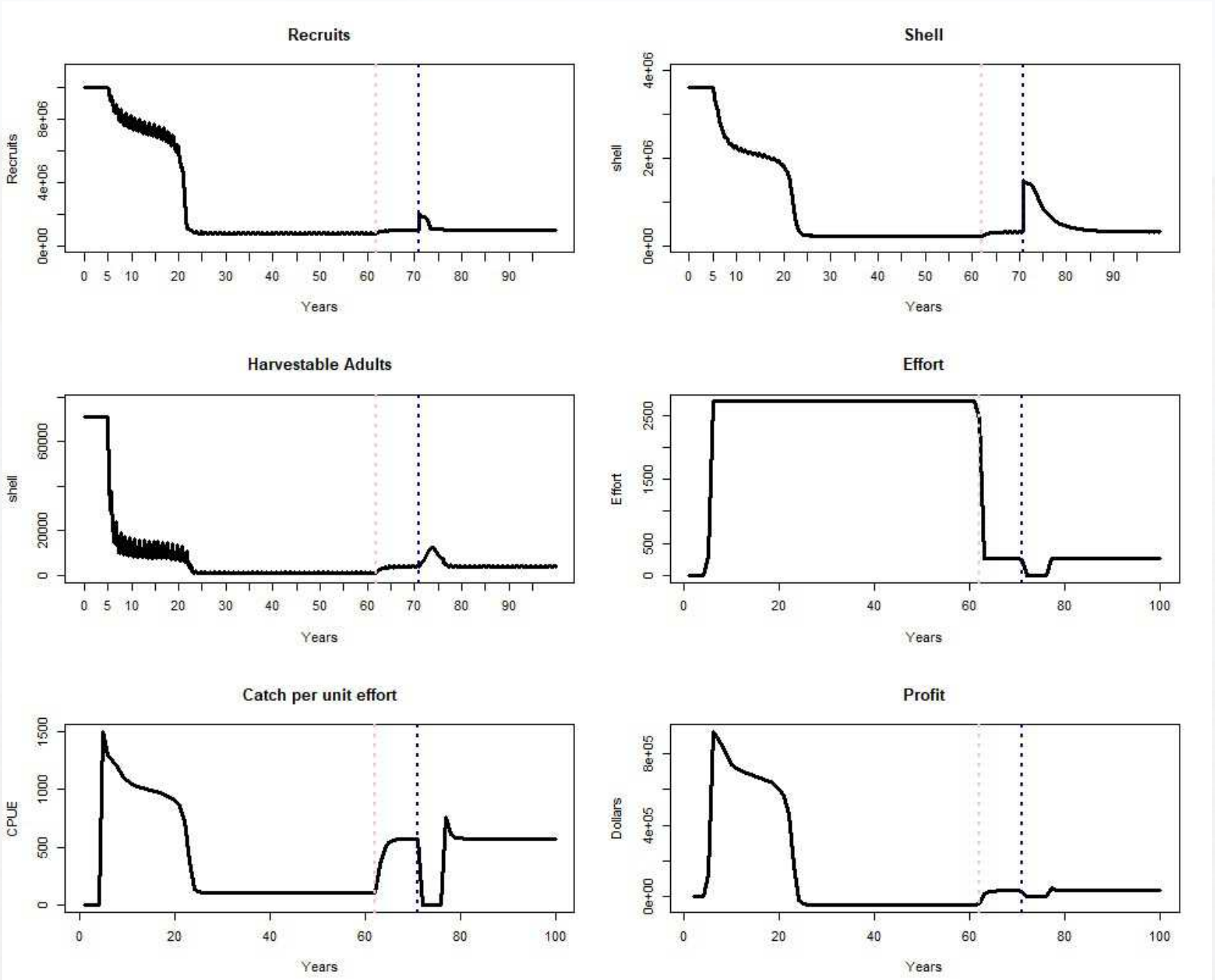
4. Inflection point



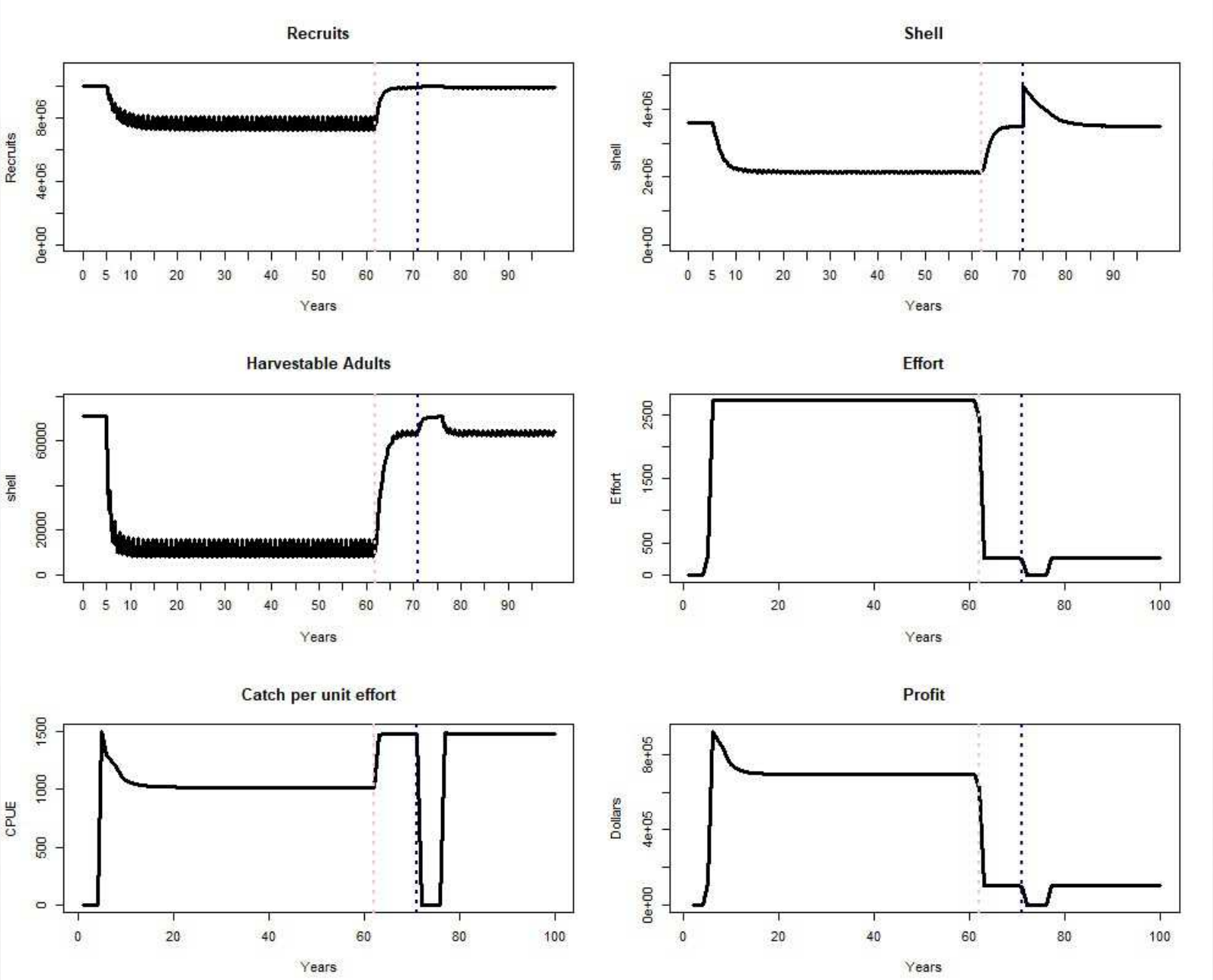
4.1 Uncertainty in shell dynamics—baseline recovery, shell-height threshold is 45%



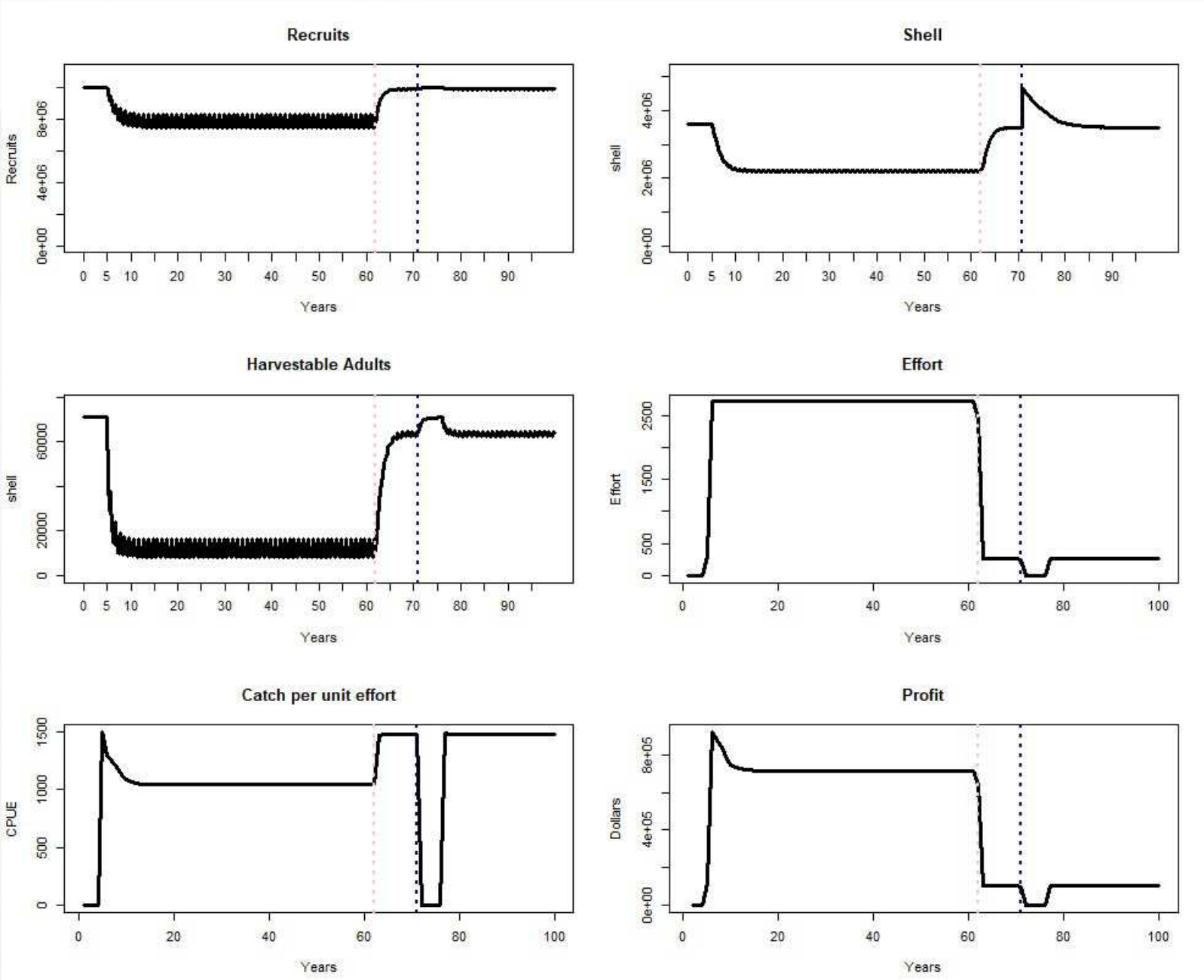
4.2 Uncertainty in shell dynamics—shell-height threshold is changed to 46%



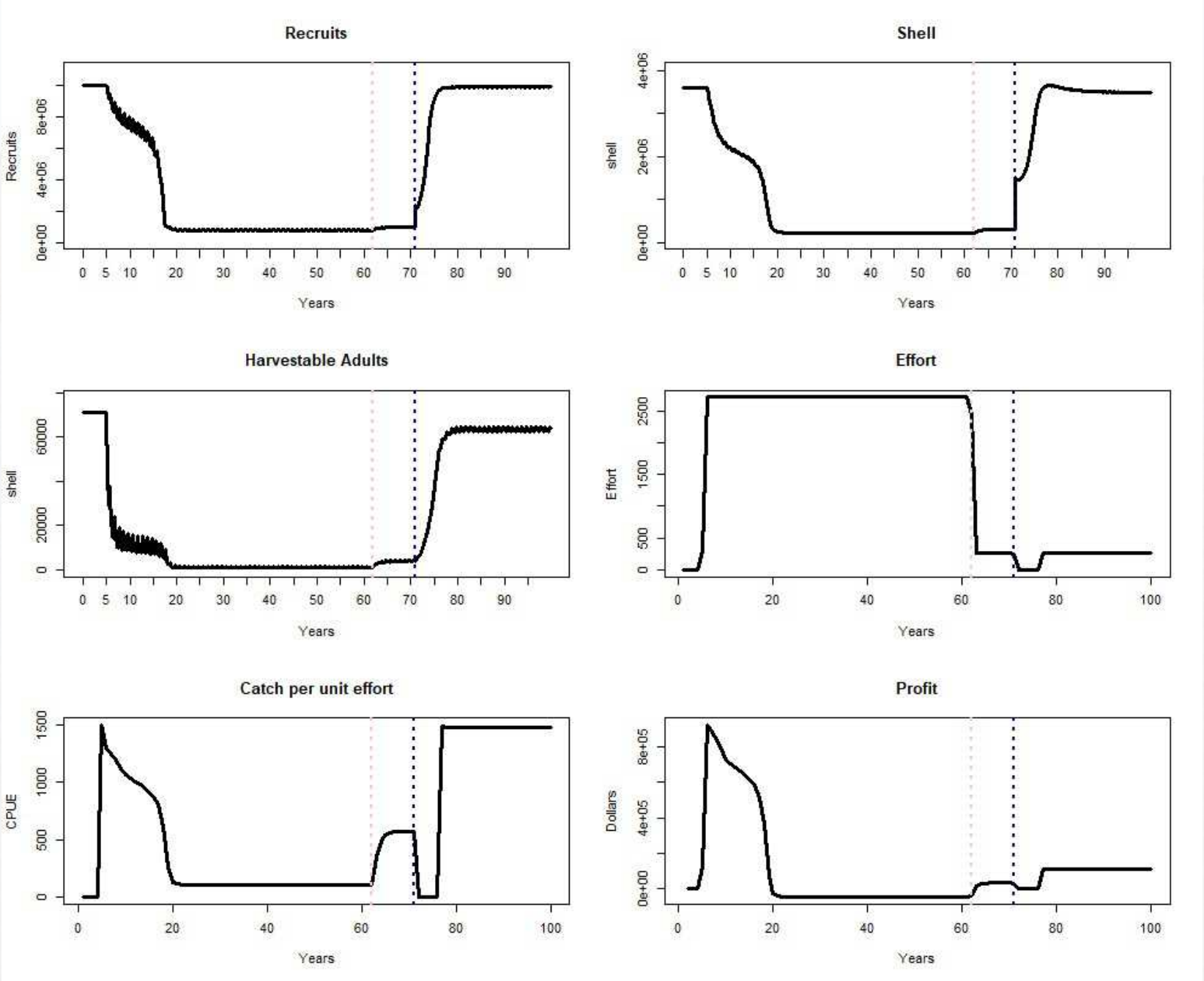
4.3 Uncertainty in shell dynamics—shell-height threshold is changed to 44%



4.4 Uncertainty in shell dynamics—shell-height steepness is changed from 0.05 to 0.04 (barely steeper)



4.5 Uncertainty in shell dynamics—shell-height steepness is changed from 0.05 to 0.06 (barely shallower)



4. Caveats and notes

- I have low confidence that these “shell dynamic” parameters are “right”—as in both precise and accurate. Not even sure this relationship between habitat and shell can be described so simply.

- Particularly, I doubt the threshold value (0.45) is so high—this is just balancing with effort and scale—i.e. we could develop a similar looking system with more effort (depletion) and a lower threshold value.

- BUT the values we’re using seem to be useful for what we are trying to represent: a fishery that collapsed somewhat recently after appearing stable for quite a while.

4. Take-home points: uncertainty in shell dynamics

1. If there is a threshold, we've probably crossed it. But we don't know what level it's at. And we can't tell with our simulation models

3. Discussion and questions (so far)

5. Simulation results: Review and updated harvest months

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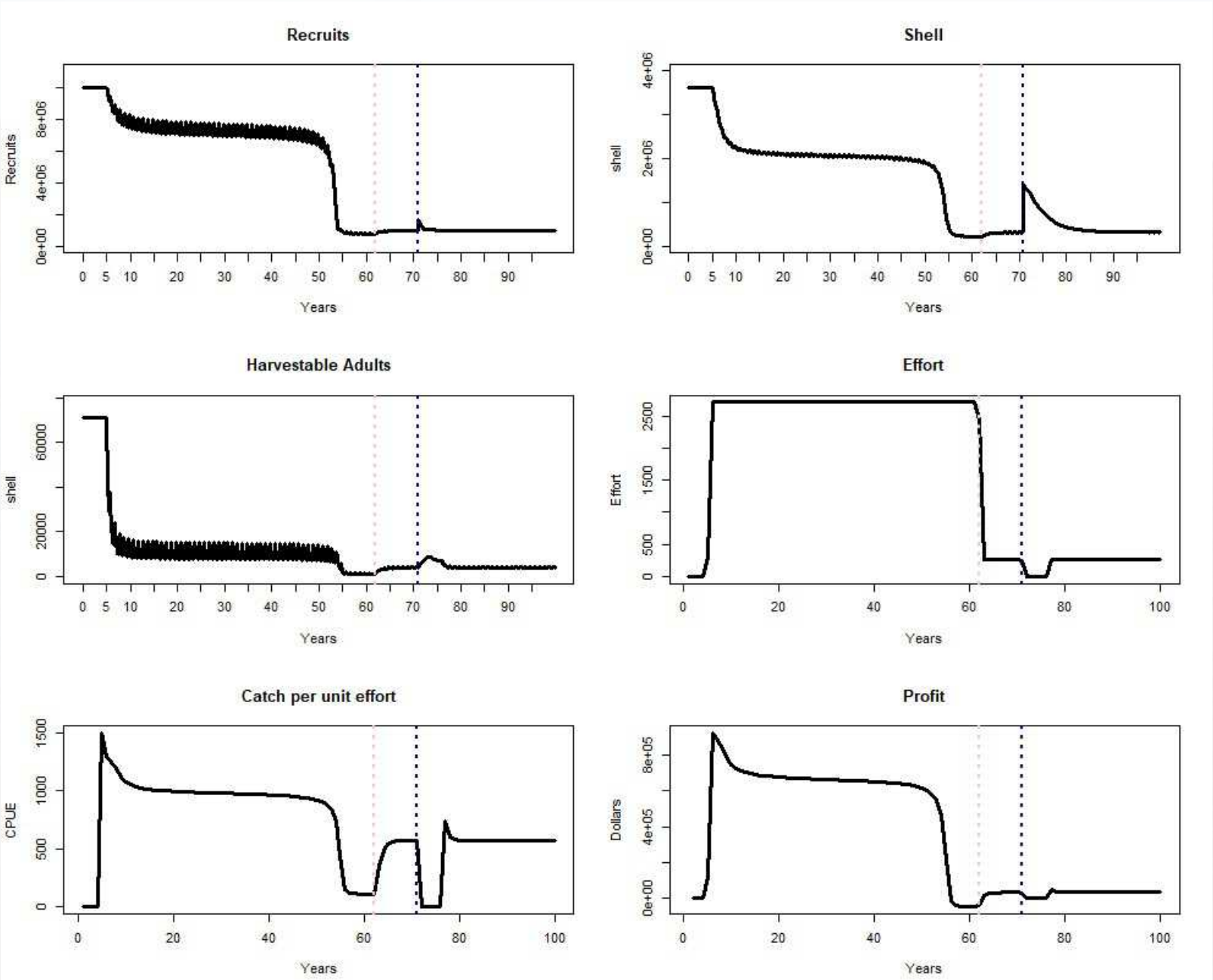
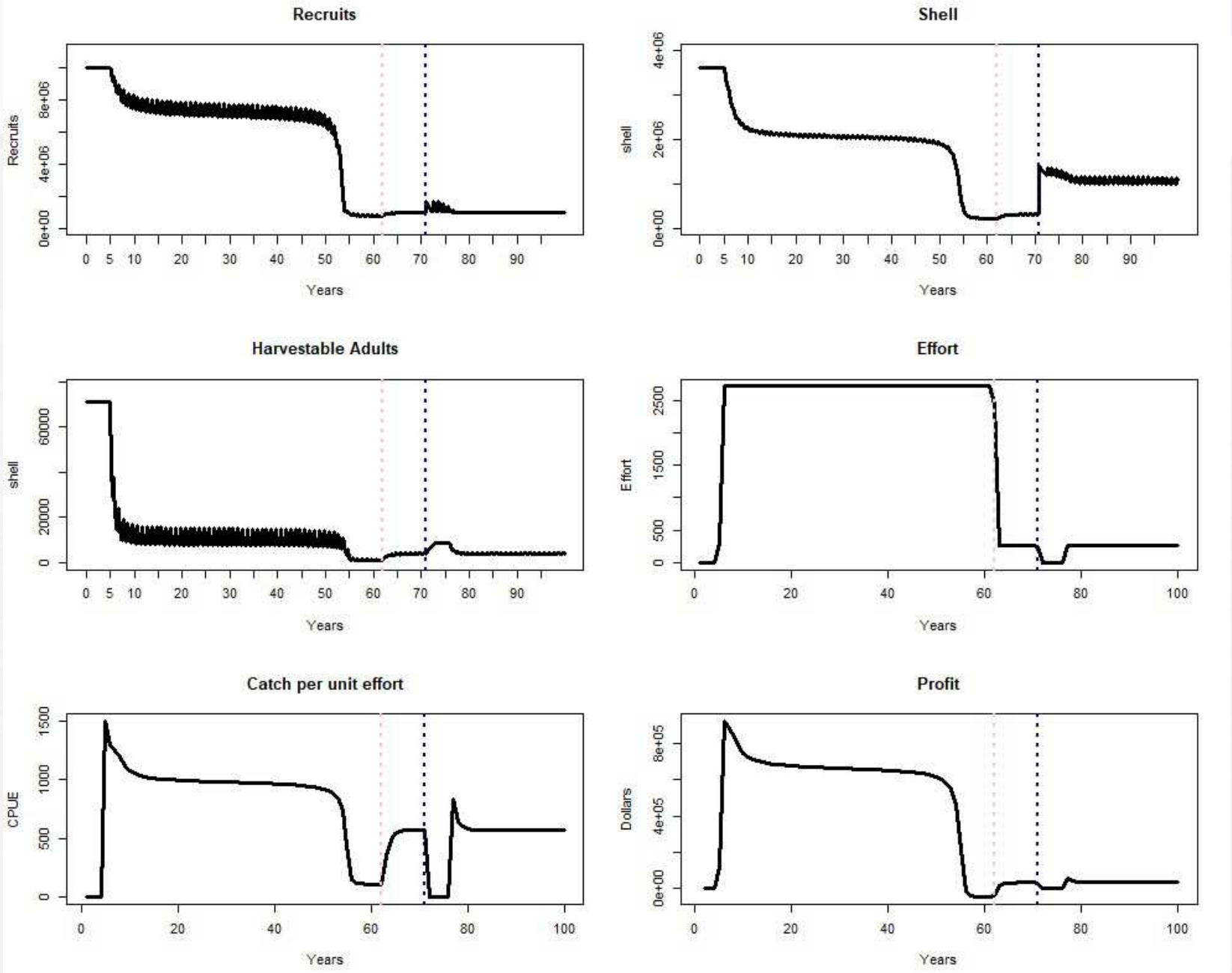
5. Simulation results: Continual restoration

- Look at how continued restoration (annual small amounts)
- I’ve assumed if major restoration (one time deal) is taking about 33% initial shell to bring back, then annual shelling will be more like 5% (even this is optimistic)

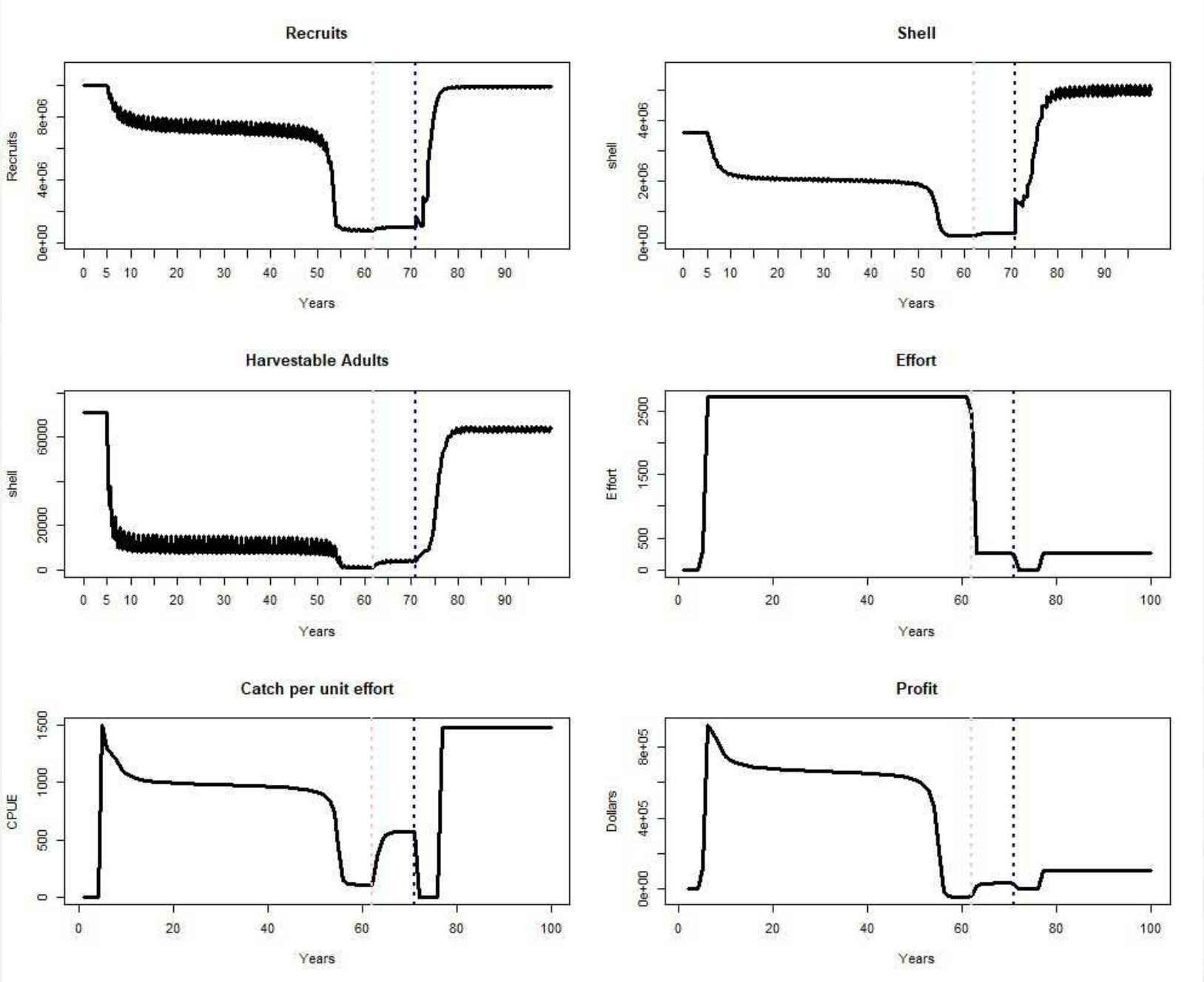
5.1 Baseline, restoring only 30% initial shell (insufficient), no annual restoration



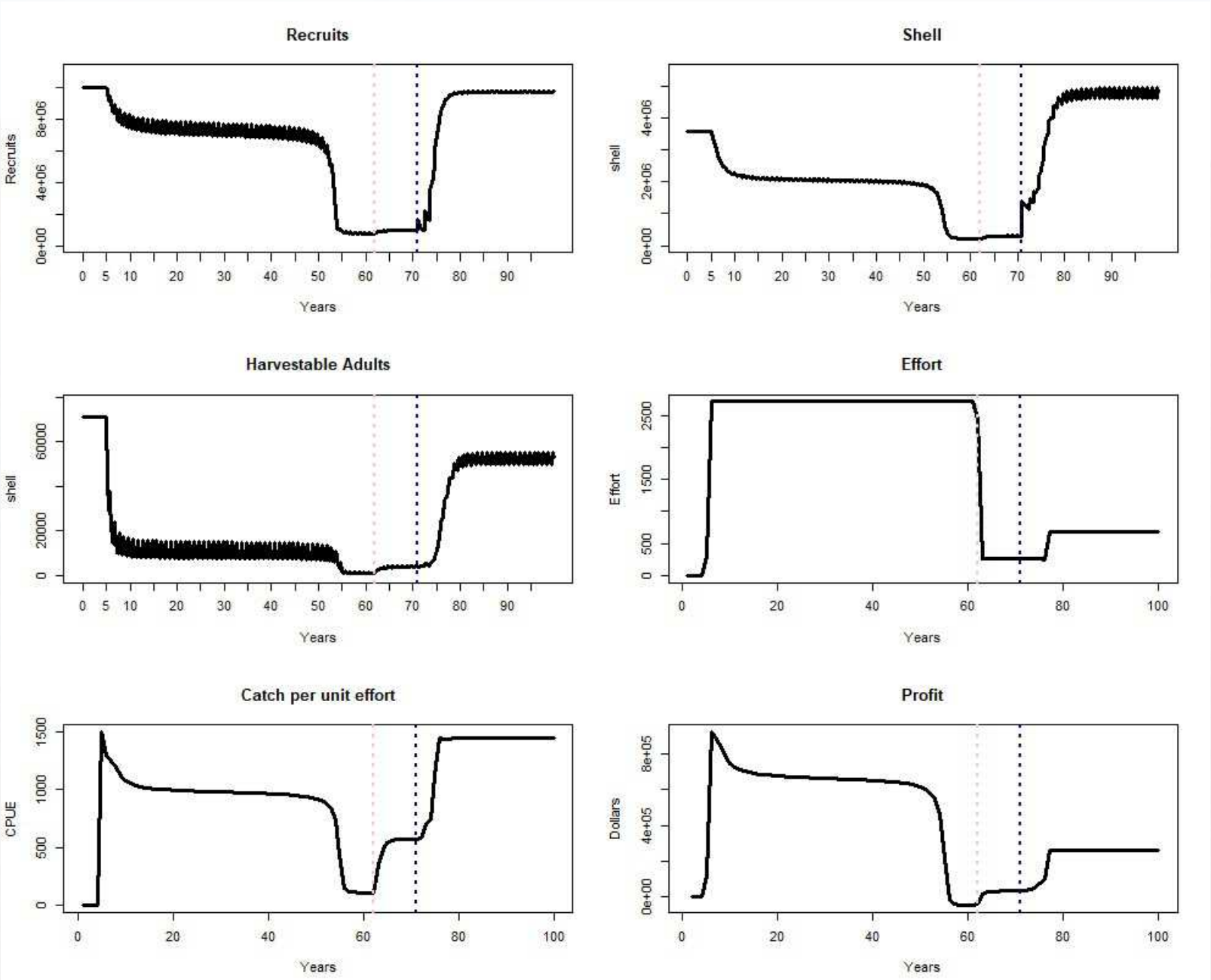
5.2 Baseline, restoring only 30% (insufficient), 5% annual restoration



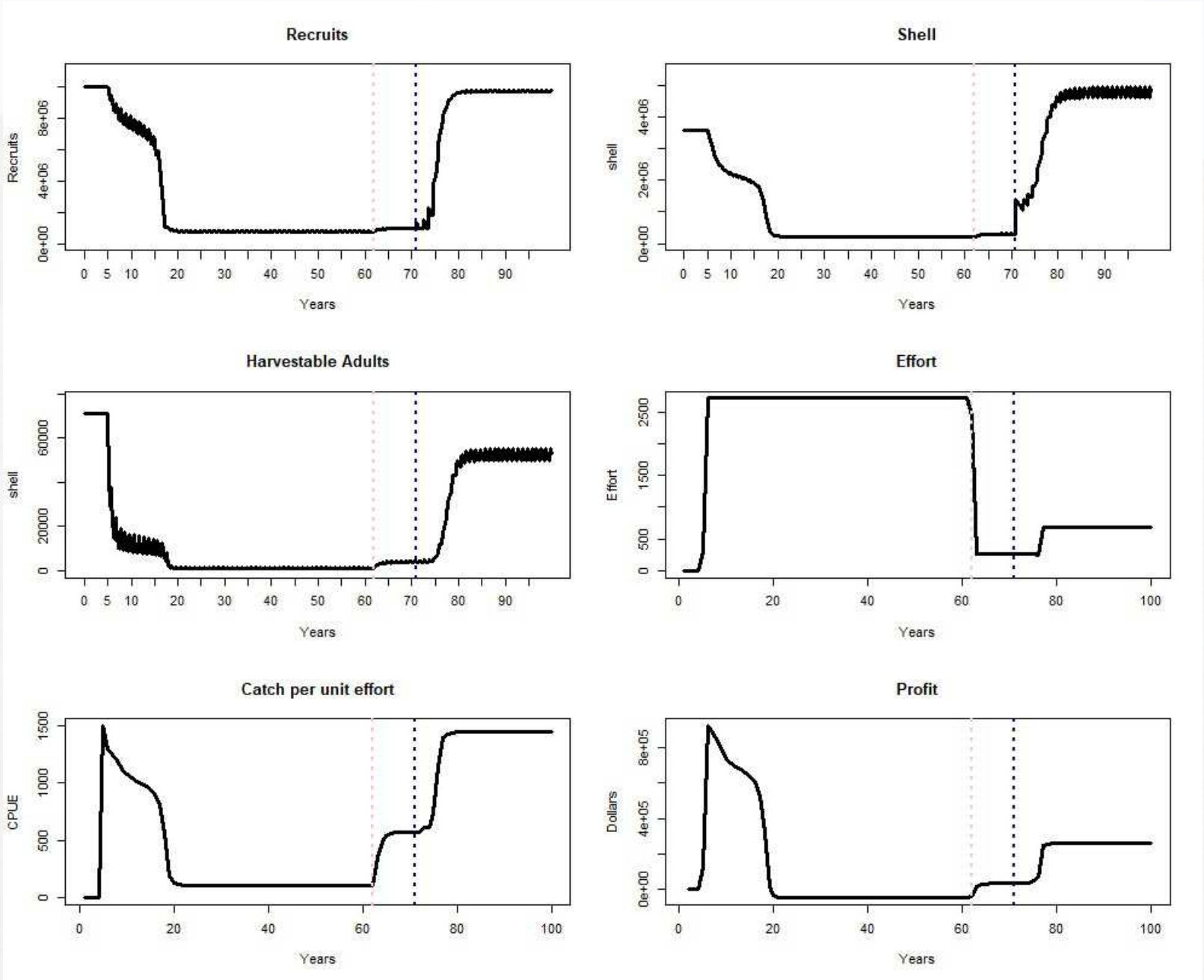
5.3 Baseline, restoring only 30% (insufficient), 10% annual restoration



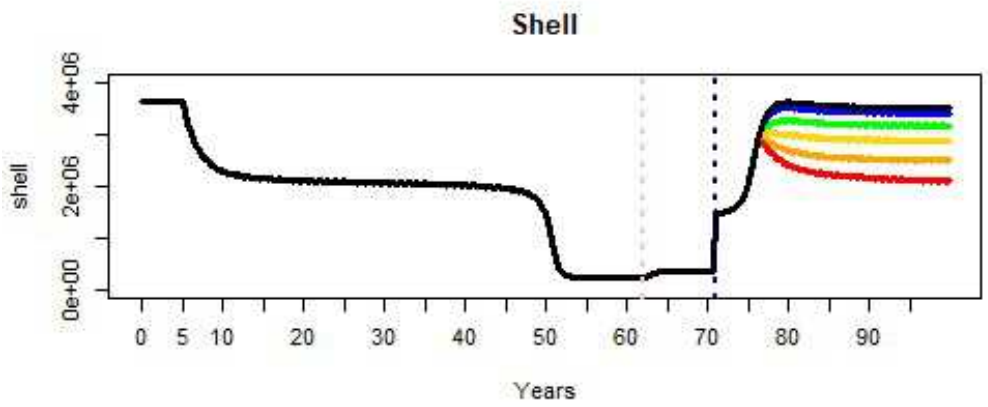
5.4 Baseline, restoring only 30% (insufficient), 10% annual restoration, no closure, 25% effort 5 years post-restoration

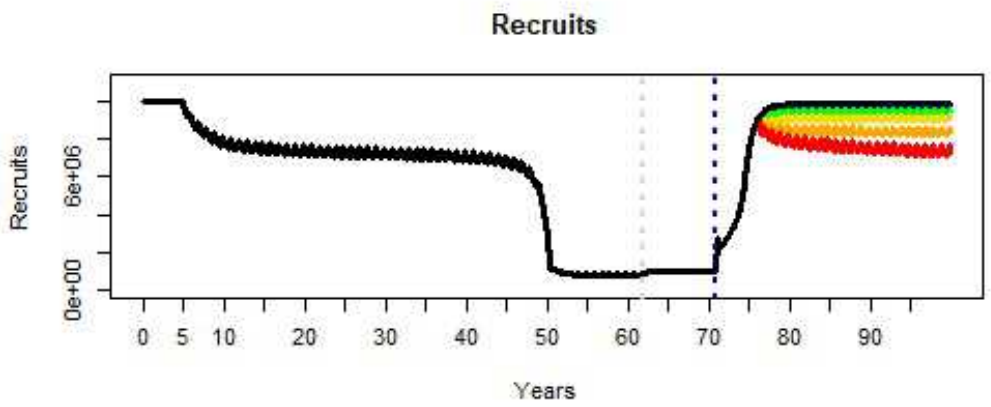


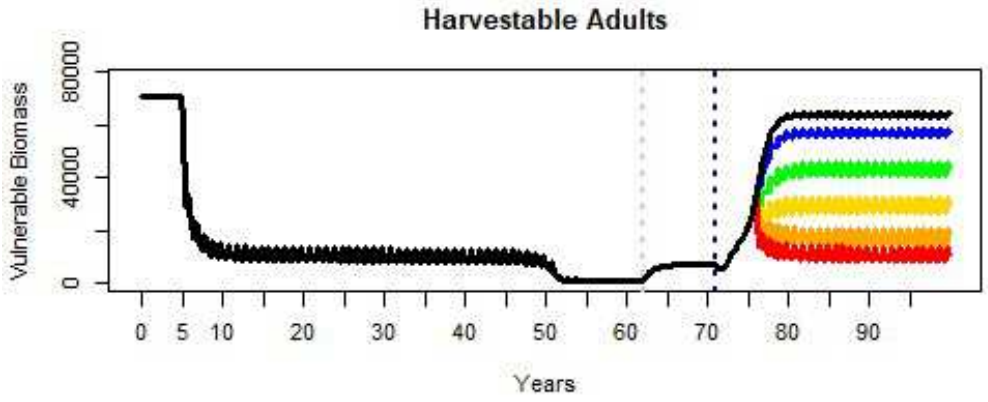
5.5 Same as previous, but increasing shell-height threshold to 0.47 (from 0.45)

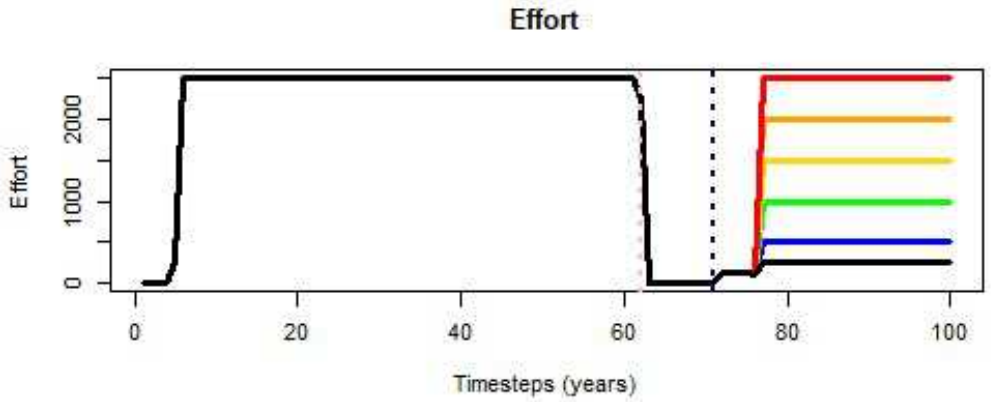


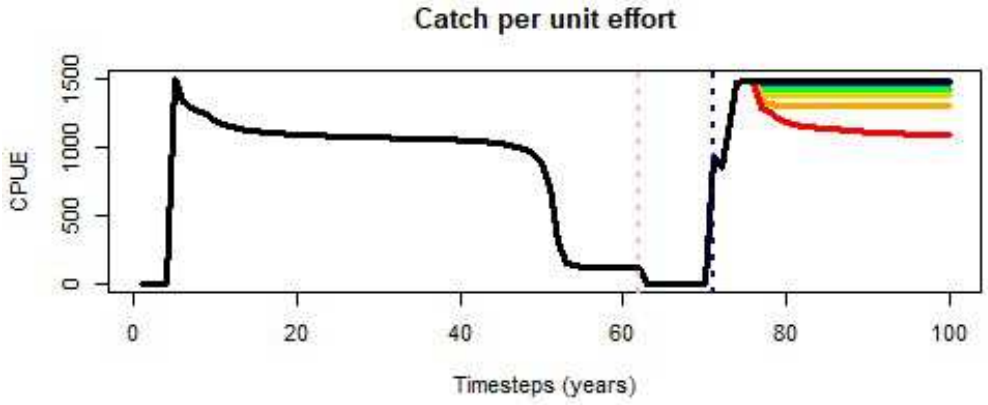
Look at different levels of post-restoration effort—no annual

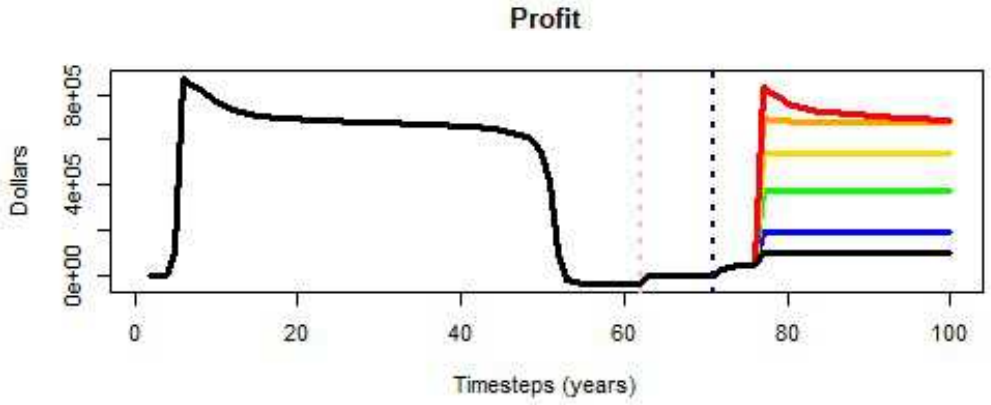




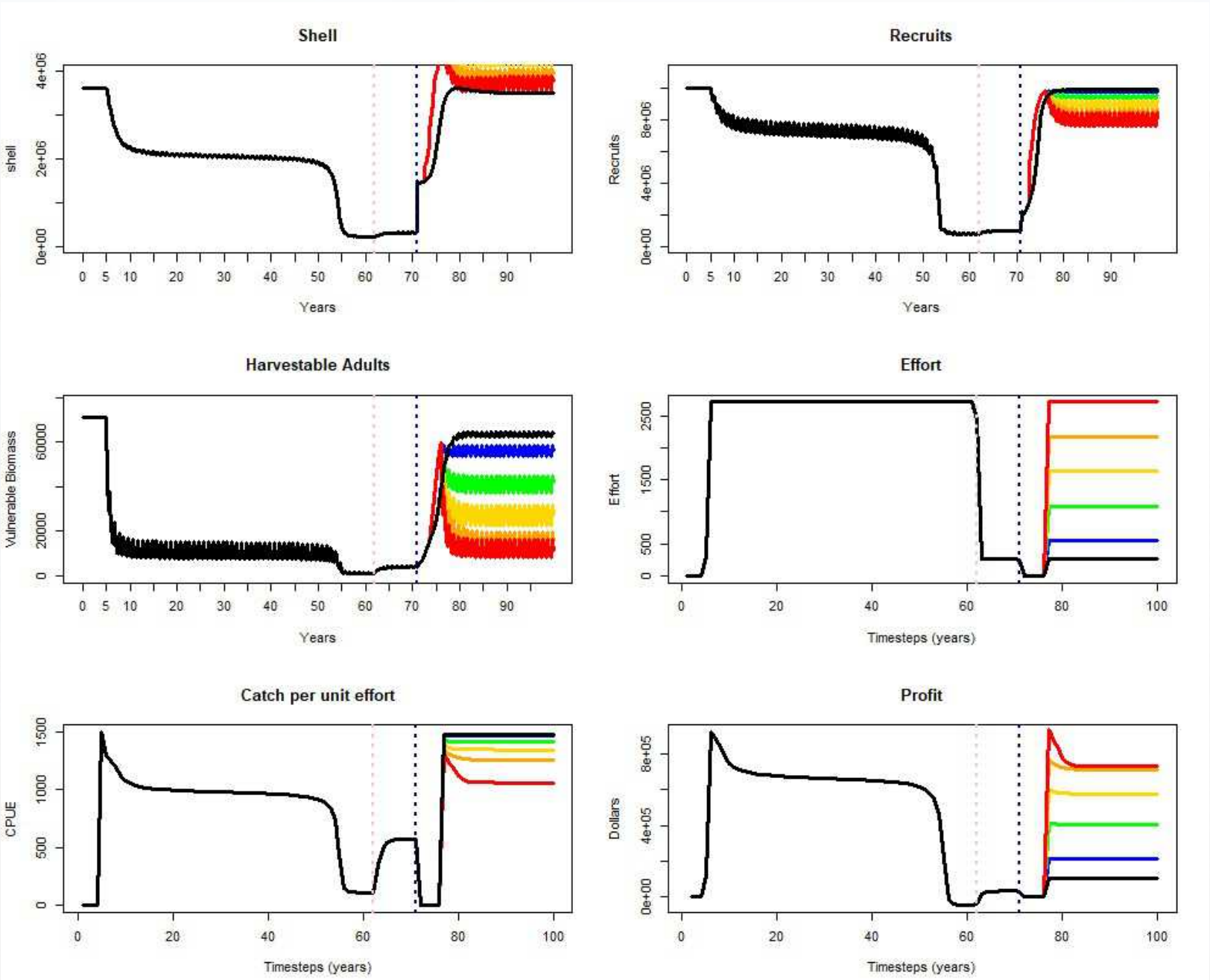




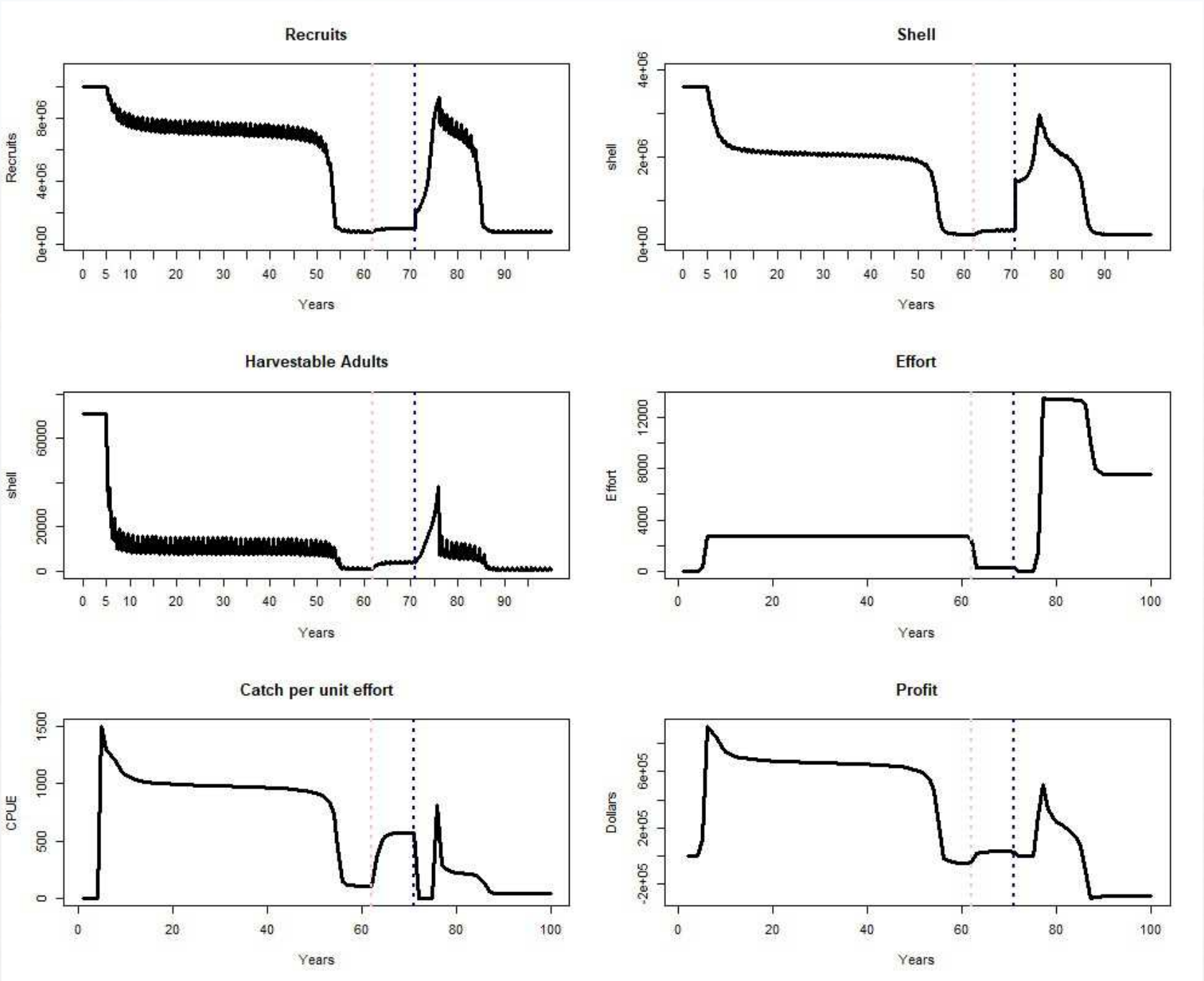




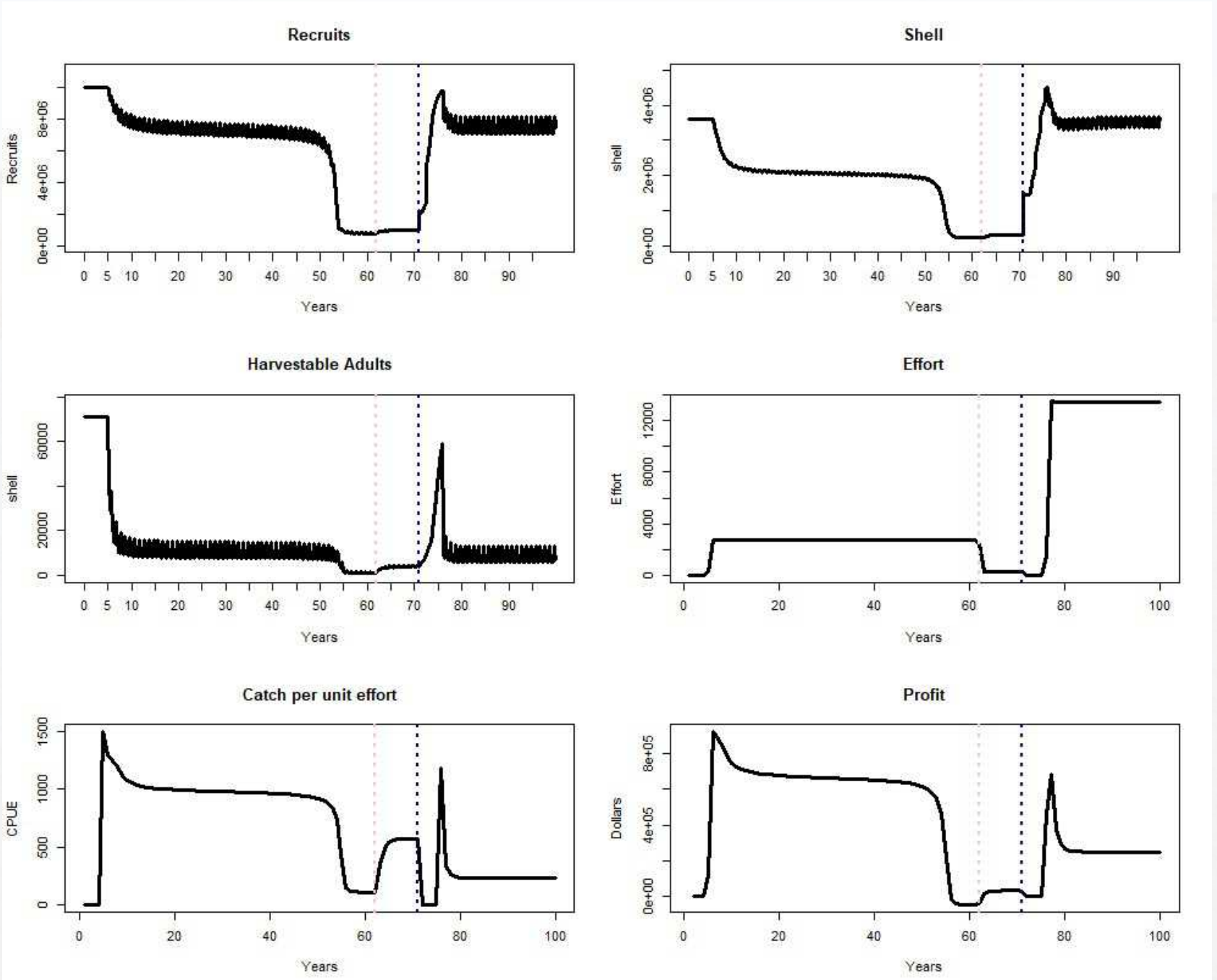
5.6 Annual restoration with increasing effort post-recovery—limited entry for 20-100% pre-collapse effort



What about bioeconomic entry (no limited entry)?



5.7 Annual restoration with open access (kinda) effort



5. Caveats and notes

- I think the cost of annual restoration at the levels I showed would be pretty high, and may not be feasible, especially at larger scales

- Currently the model doesn't allow for the possibility of additional material added to *hurt* oysters, such as by burying it. The models essentially adds the material without covering up any live oysters, which is probably not possible in real life.

- Obvious idea is to expand area but not cover oysters, but that would actually be something different than what we've simulated—it would be augmenting other, non-recovered areas with a small amount of habitat, and it probably wouldn't work

5. Take-home points: Annual restoration

1. If there is a way to do this that is (a) affordable and (b) doesn't hurt oysters, it would offer some buffer against other uncertainty, including harvest
2. I don't think this is or should be surprising us
3. I do think the financial costs and logistical concerns are greater with this strategy than with others considered (but all have issues, see enforcement).

3. Discussion and questions (so far)

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8. At least three things to work on

- Scaling and fit of simulations—larger reefs, fit to historical effort
  - Increase confidence in “levels”
  - Cannot overcome issues of uncertainty wrt depensation
- Stochasticity—adding in random “noise” in
  - Process, e.g., recruitment
  - Fishing (maybe with open access?)
  - How mgmt. “sees” fishery (active harvest mgmt.)
- Spatially explicit structure (multiple bars at once)
  - Can be done, will take some time

Thank you for your patience!