## Appendix E: Model Differences between T13B6 and T02A

William Stockhausen 23 April, 2017

#### Introduction

This appendix presents results from the comparison of the "exactly equivalent" TCSAM2013 model T13B6 and the TCSAM model T02A. Ideally, these results should be identical, but given finite numerical accuracy and the numerical minimization process used in fitting the models, this expectation is unrealistic. The following plots demonstrate the differences between the two models, for all quantities examined, are extremely small and indicate the models are, indeed, "exactly equivalent."

#### Population processes

#### **Natural mortality**

## natural mortality

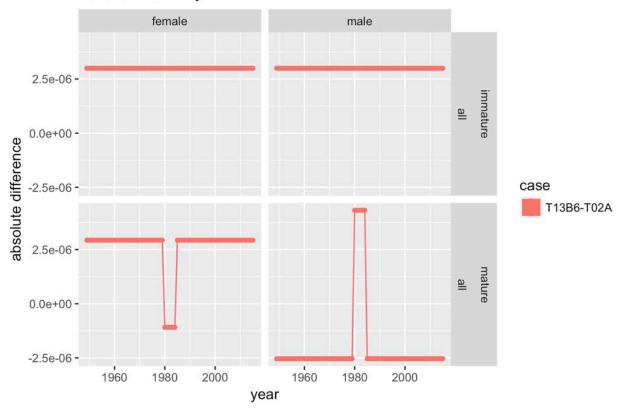


Figure 1. Differences for natural mortality.

## **Probability of terminal molt**

## 

size (mm CW)

Figure 2. Differences for pr(Terminal Molt).

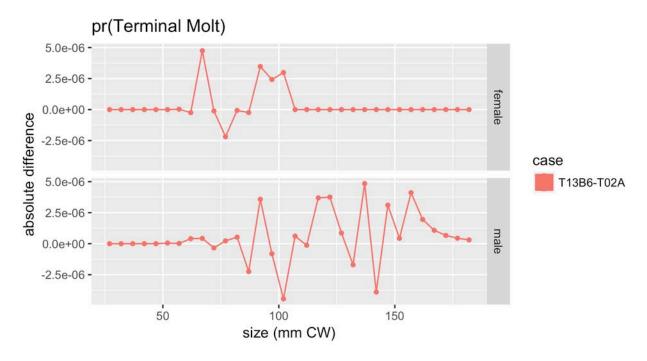


Figure 3. Differences for pr(Terminal Molt).

## Mean growth

# mean growth 5e-04 0e+00 -5e-04 0e+00 -5e-04 0e+00 -5e-04 size (mm CW)

Figure 4. Differences for mean growth.

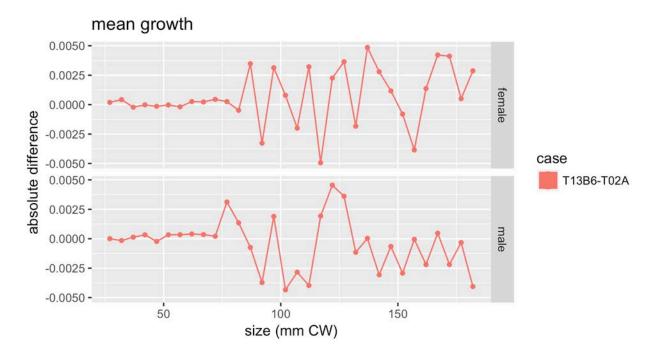


Figure 5. Differences for mean growth.

#### **Growth matrices**

plotting growth matrix for female plotting growth matrix for male

# growth matrices for female

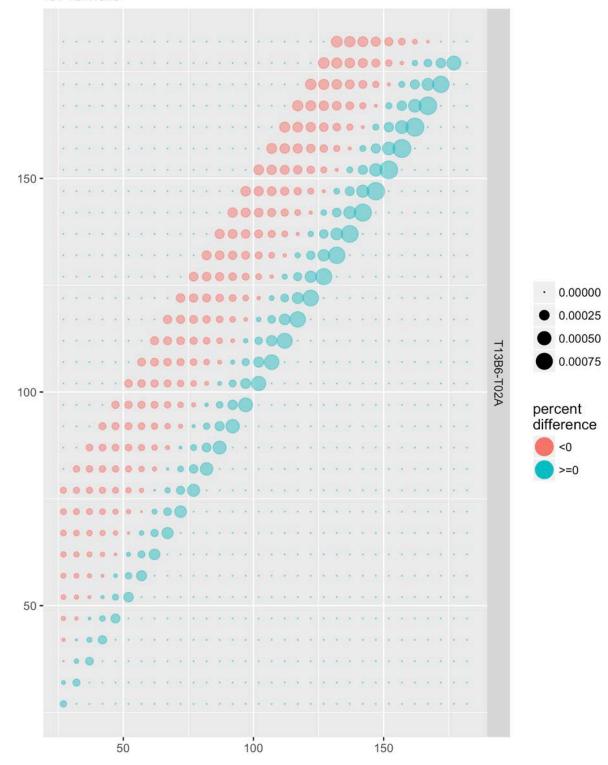


Figure 6. Growth matrix differences for female.

# growth matrices for male 150 -0.000 0.001 0.002 T13B6-T02A 0.003 100 percent difference <0 >=0 50 -100 150 50

Figure 7. Growth matrix differences for male.

# growth matrices for female

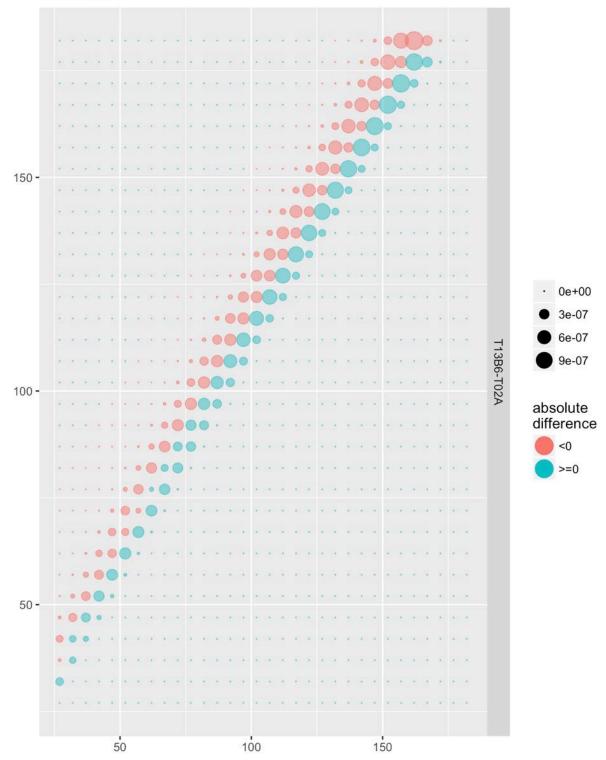


Figure 8. Growth matrix differences for female.

# growth matrices for male 150 -0.0e+00 4.0e-07 8.0e-07 T13B6-T02A 1.2e-06 1.6e-06 100 absolute difference 50 -

100

150

Figure 9. Growth matrix differences for male.

50

## **Size distribution for recruits**

## recruitment size distribution

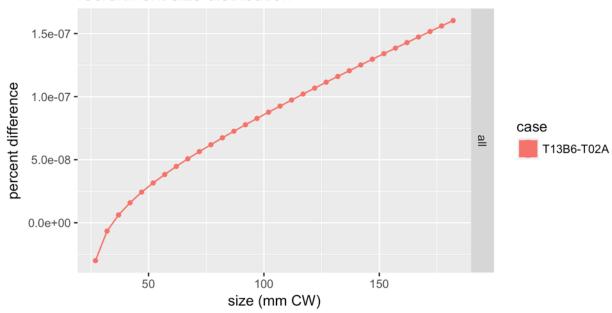


Figure 10. Differences for recruitment size distribution.

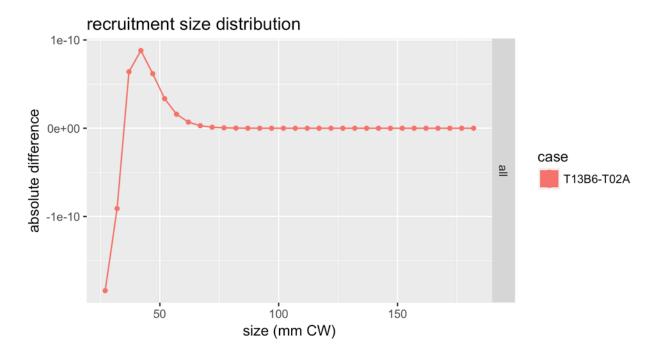


Figure 11. Differences for recruitment size distribution.

## Population results

## Recruitment

## recruitment

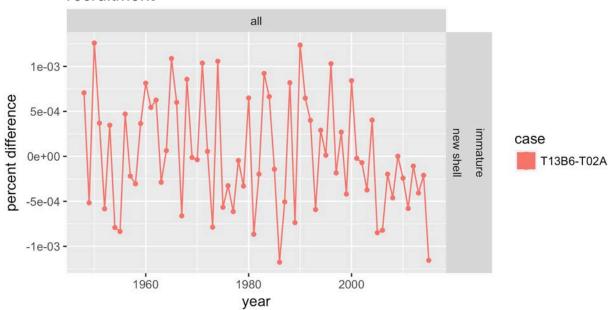


Figure 12. Differences for recruitment.

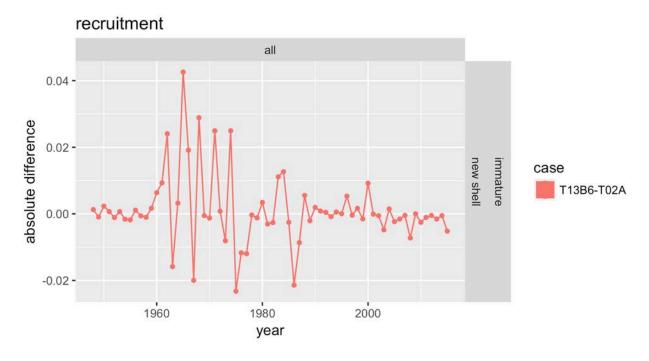


Figure 13. Differences for recruitment.

## Population abundance

## population abundance

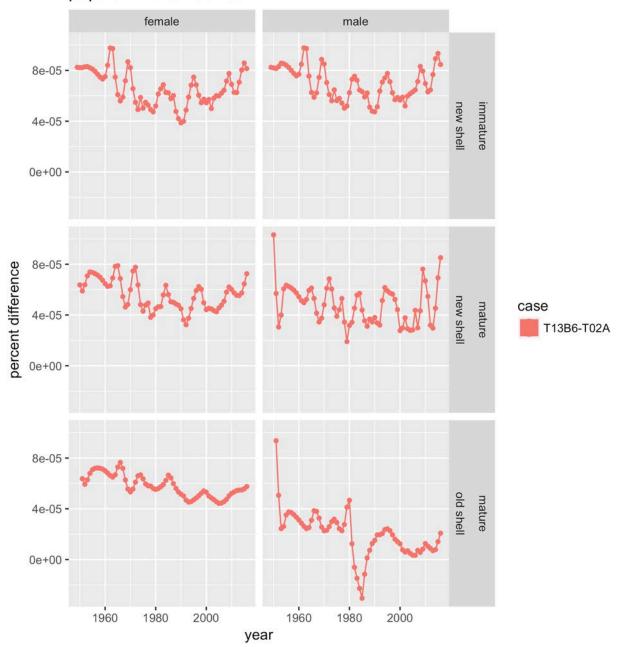


Figure 14. Differences for population abundance.

## population abundance female male 0.004 -0.003 immature new shell 0.002 -0.001 -0.000 -0.004 absolute difference 0.003 new shell case 0.002 -T13B6-T02A 0.001 -0.000 -0.004 -0.003 old shell 0.002 -0.001 -0.000 -1980 2000 2000 1960 1960 1980

year

Figure 15. Differences for population abundance.

# population abundance for female immature new shell 150 -0.00005 0.00010 T13B6-T02A 0.00015 100 percent difference >=0 50 -1960 1980 2000

Figure 16. Differences for population abundance for female immature new shell.

# population abundance for female mature new shell 150 -0.00005 0.00010 T13B6-T02A 0.00015 100 percent difference <0 >=0 50 -

Figure 17. Differences for population abundance for female mature new shell.

1980

2000

1960

# population abundance for female mature old shell

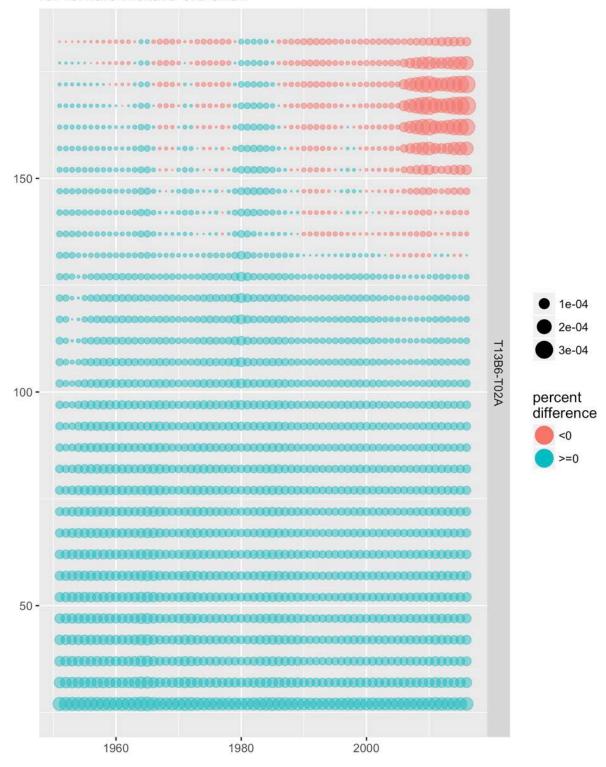


Figure 18. Differences for population abundance for female mature old shell.

# population abundance for male immature new shell 150 -0.00005 0.00010 0.00015 T13B6-T02A 0.00020 100 percent difference <0 >=0 50 -1960 1980 2000

Figure 19. Differences for population abundance for male immature new shell.

## population abundance for male mature new shell

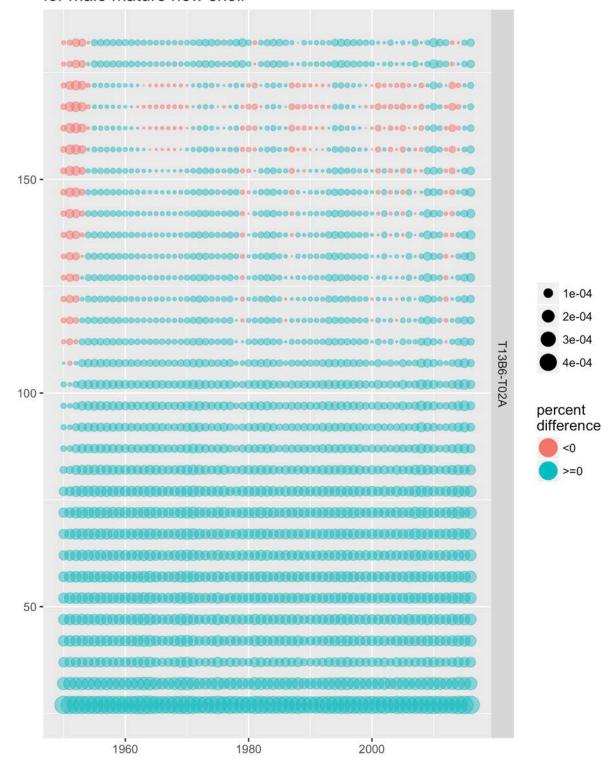


Figure 20. Differences for population abundance for male mature new shell.

## population abundance for male mature old shell

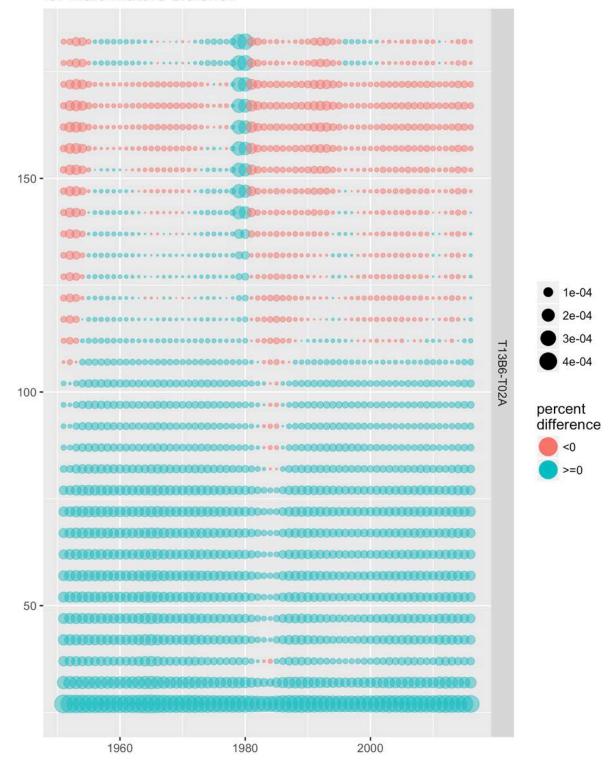


Figure 21. Differences for population abundance for male mature old shell.

# population abundance for female immature new shell

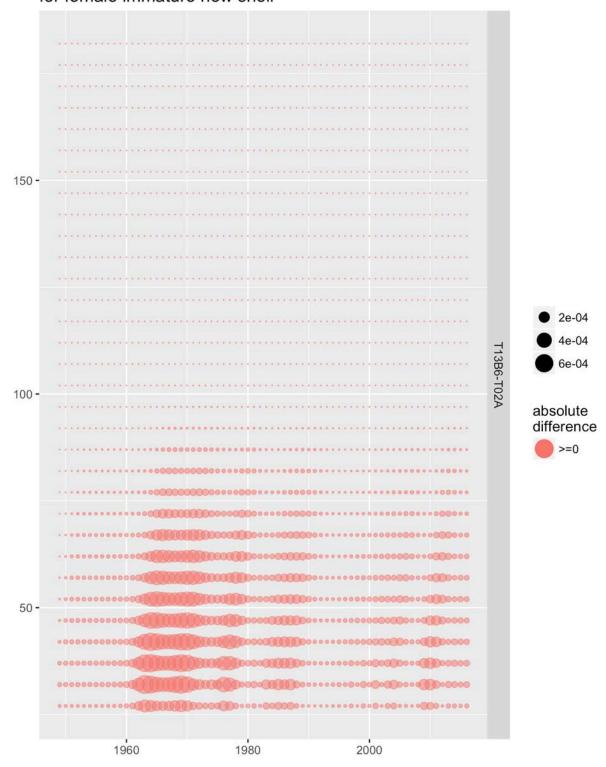


Figure 22. Differences for population abundance for female immature new shell.

# population abundance for female mature new shell

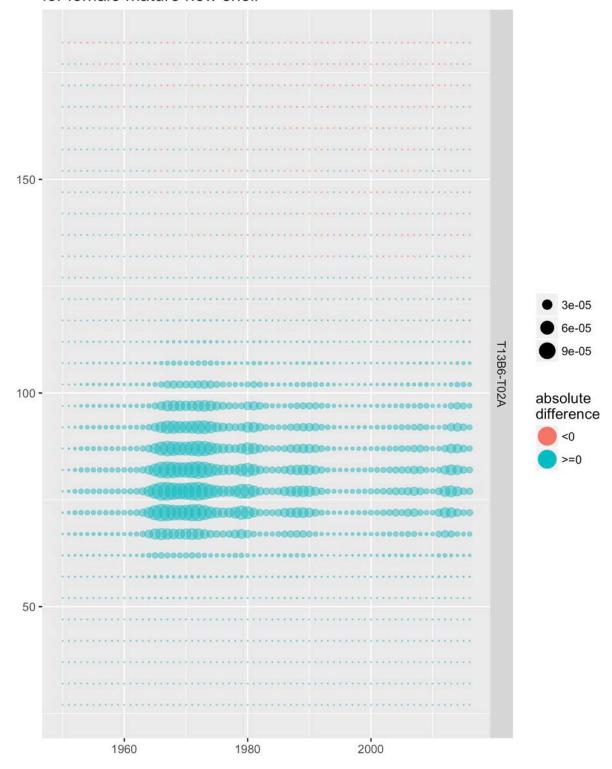


Figure 23. Differences for population abundance for female mature new shell.

# population abundance for female mature old shell

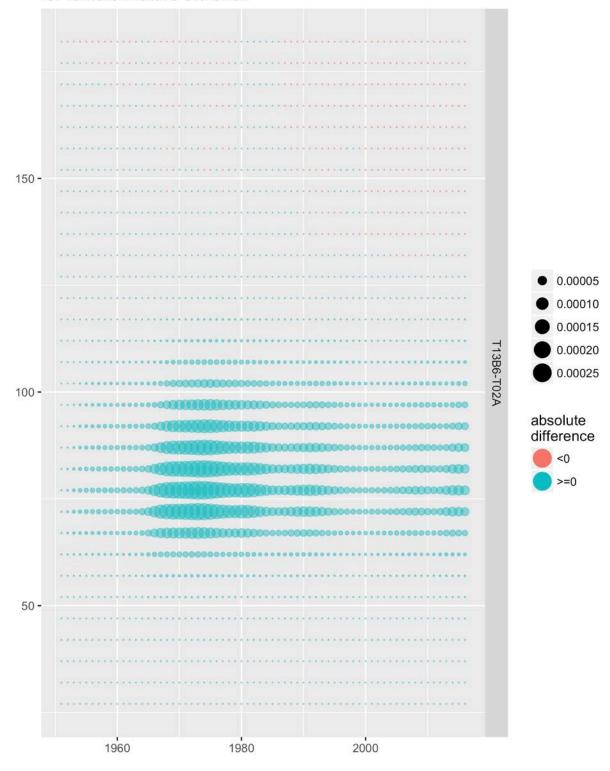


Figure 24. Differences for population abundance for female mature old shell.

# population abundance for male immature new shell

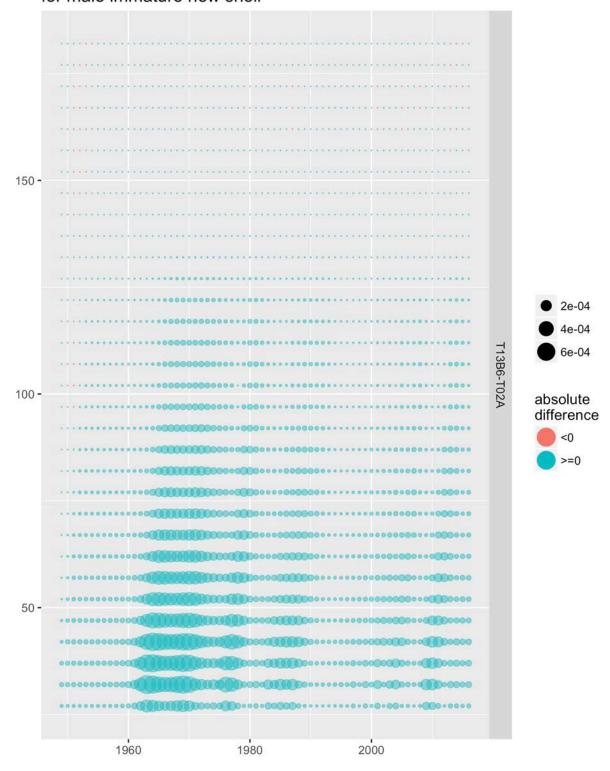


Figure 25. Differences for population abundance for male immature new shell.

# population abundance for male mature new shell

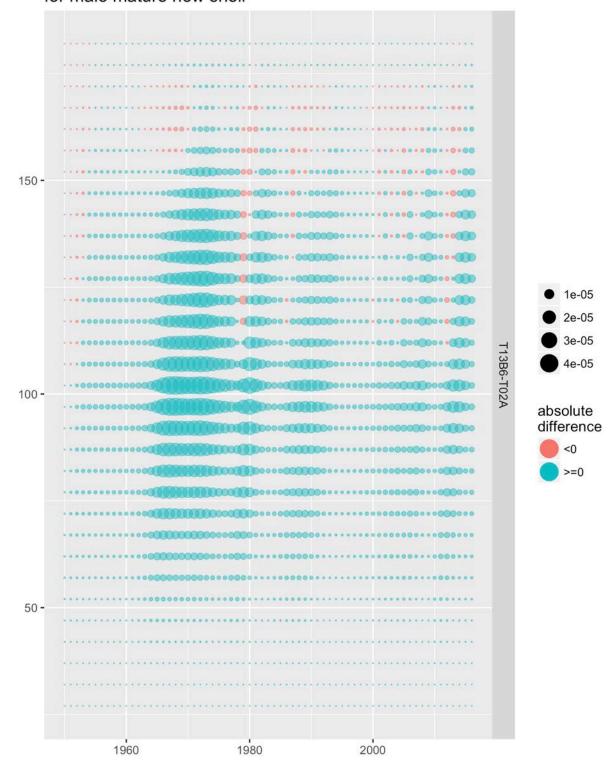


Figure 26. Differences for population abundance for male mature new shell.

# population abundance for male mature old shell

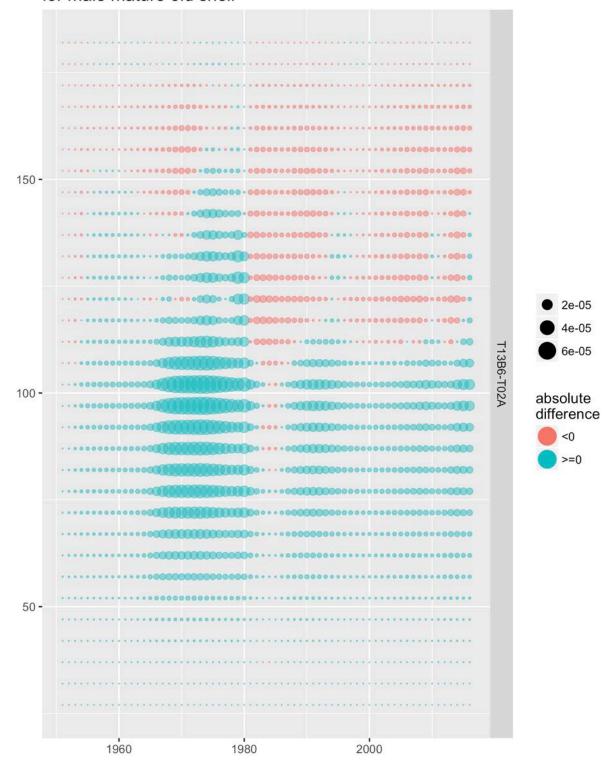


Figure 27. Differences for population abundance for male mature old shell.

## **Biomass**

## population biomass

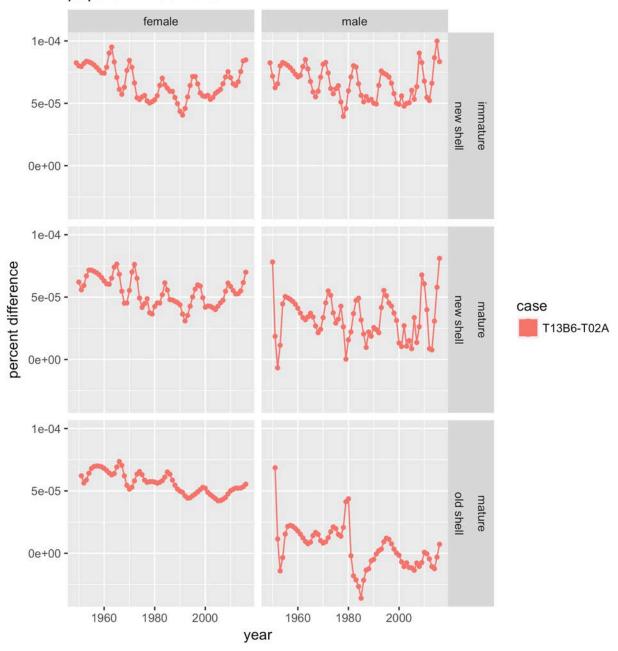


Figure 28. Differences for population biomass.

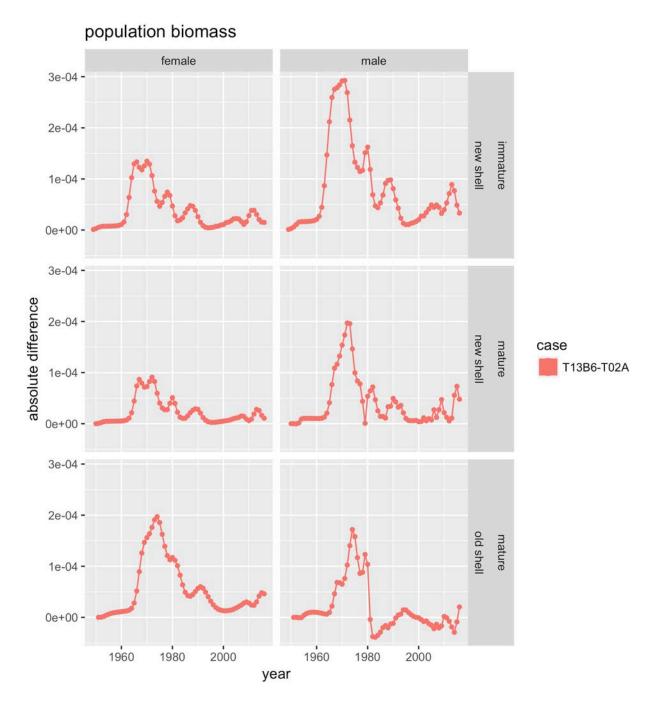


Figure 29. Differences for population biomass.

## Surveys

## **Survey catchability**

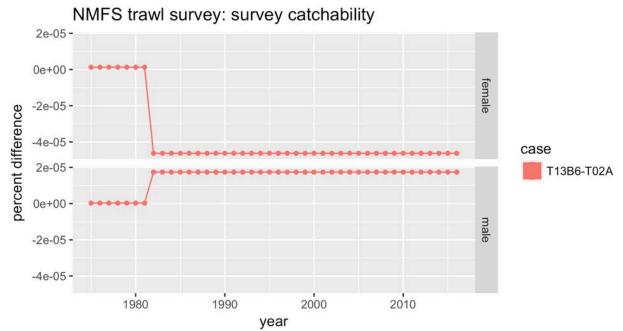


Figure 30. Differences for NMFS trawl survey: survey catchability.

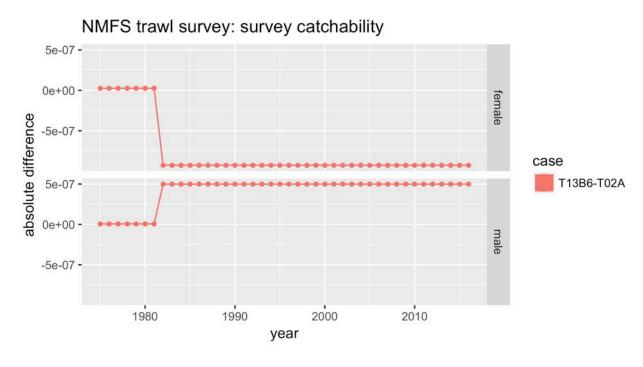


Figure 31. Differences for NMFS trawl survey: survey catchability.

#### **Survey selectivity functions**

NMFS trawl survey survey selectivity for female all maturity all shell

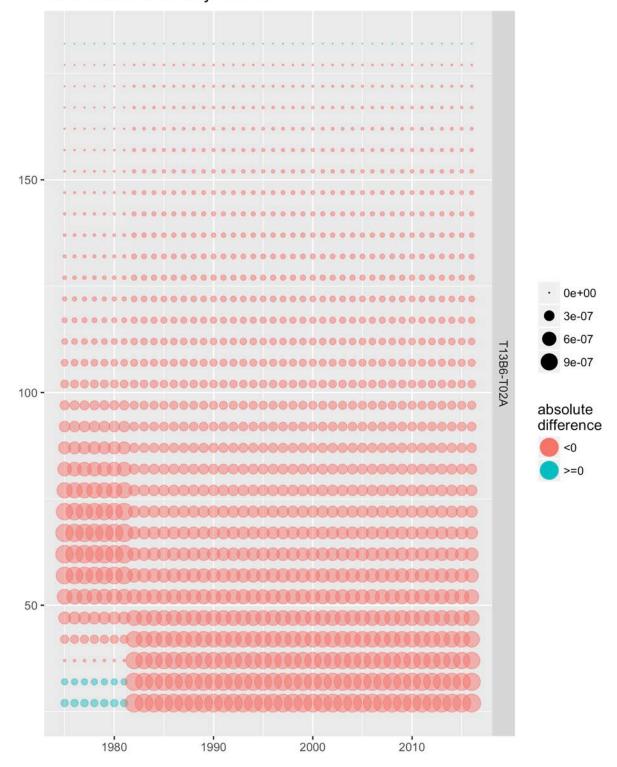


Figure 32. Differences for NMFS trawl survey survey selectivity for female all maturity all shell.

# NMFS trawl survey survey selectivity for male all maturity all shell

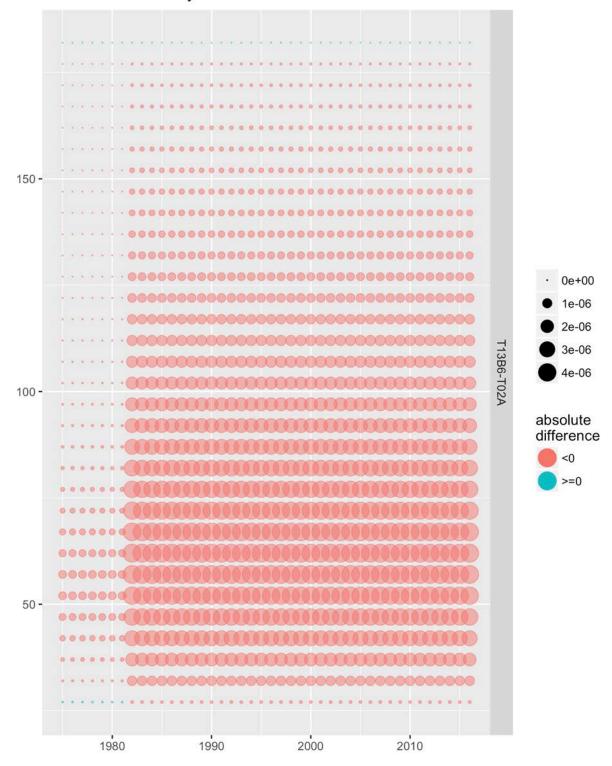


Figure 33. Differences for NMFS trawl survey survey selectivity for male all maturity all shell.

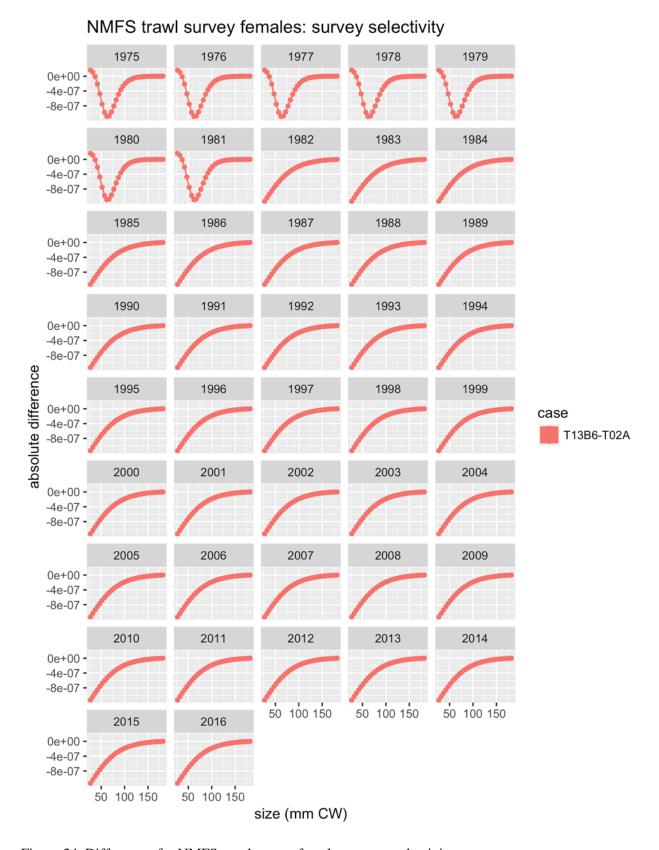


Figure 34. Differences for NMFS trawl survey females: survey selectivity.

#### NMFS trawl survey males: survey selectivity 0e+00 --1e-06 --2e-06 --3e-06 --4e-06 **-**0e+00 ---1e-06 ---2e-06 ---3e-06 ---4e-06 -0e+00 --1e-06 --2e-06 --3e-06 --4e-06 -0e+00 --1e-06 --2e-06 --3e-06 **-**-4e-06 absolute difference 0e+00 --1e-06 --2e-06 --3e-06 --4e-06 case T13B6-T02A 0e+00 --1e-06 --2e-06 --3e-06 --4e-06 -0e+00 --1e-06 --2e-06 --3e-06 --4e-06 -0e+00 --1e-06 --2e-06 --3e-06 --4e-06 -50 100 150 50 100 150 50 100 150 0e+00 --1e-06 **-**-2e-06 **-**-3e-06 **-**-4e-06 **-**50 100 150 50 100 150 size (mm CW)

Figure 35. Differences for NMFS trawl survey males: survey selectivity.

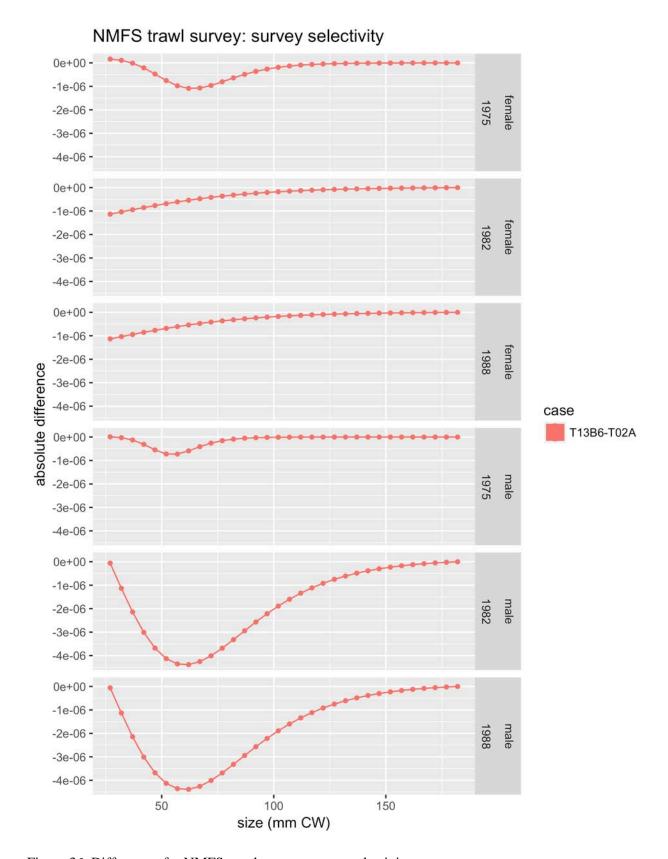


Figure 36. Differences for NMFS trawl survey: survey selectivity.

## Survey abundance

## NMFS trawl survey: survey abundance

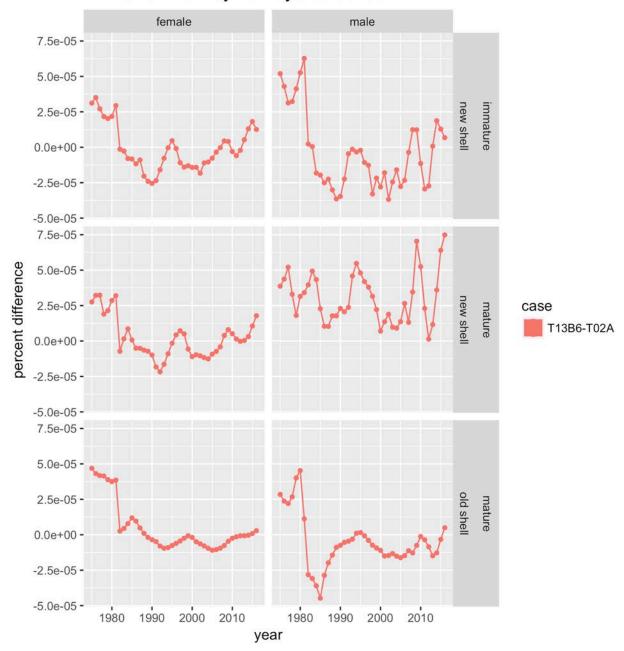


Figure 37. Differences for NMFS trawl survey: survey abundance.

## NMFS trawl survey: survey abundance

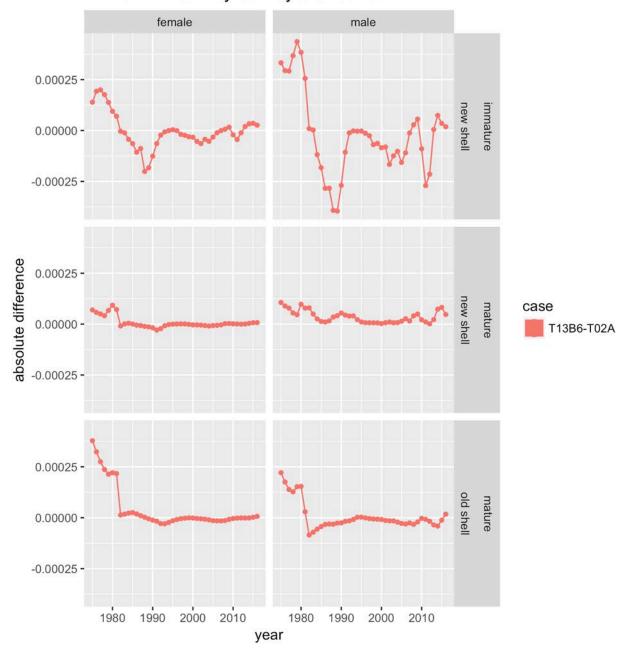


Figure 38. Differences for NMFS trawl survey: survey abundance.

## NMFS trawl survey survey abundance for female immature new shell

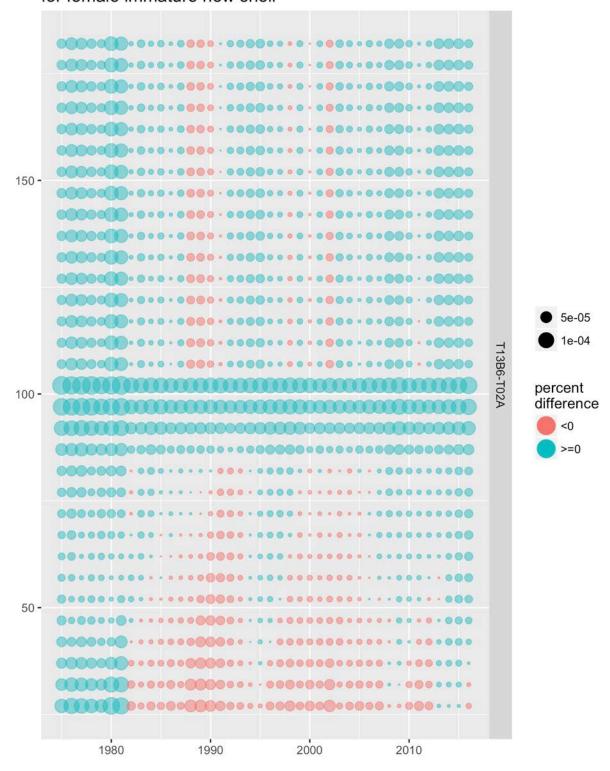


Figure 39. Differences for NMFS trawl survey survey abundance for female immature new shell.

## NMFS trawl survey survey abundance for female mature new shell

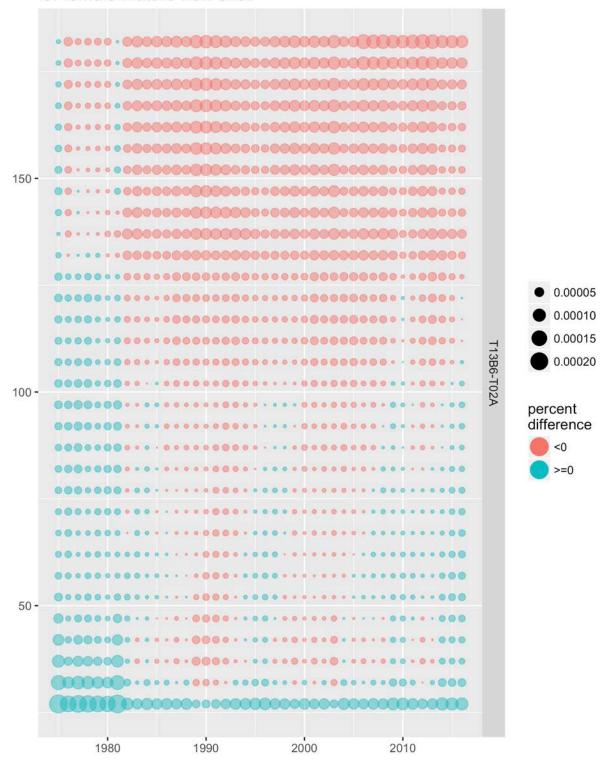


Figure 40. Differences for NMFS trawl survey survey abundance for female mature new shell.

## NMFS trawl survey survey abundance for female mature old shell

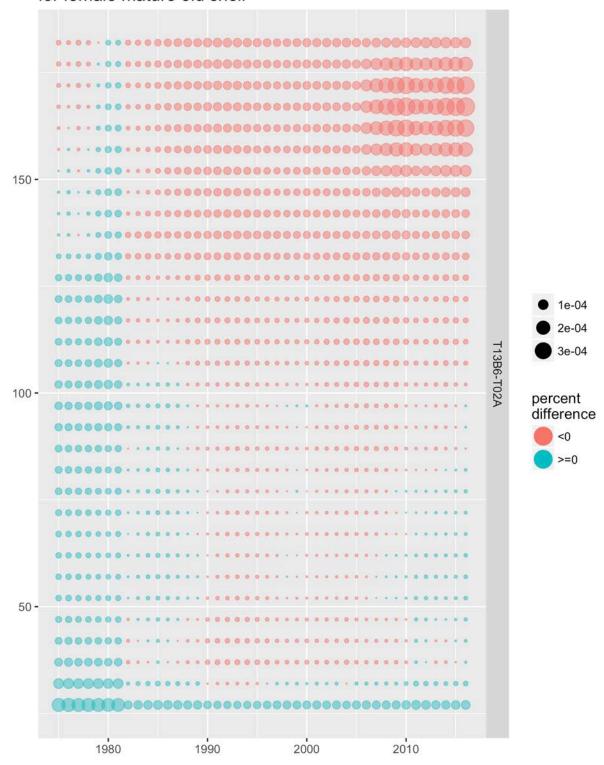


Figure 41. Differences for NMFS trawl survey survey abundance for female mature old shell.

## NMFS trawl survey survey abundance for male immature new shell

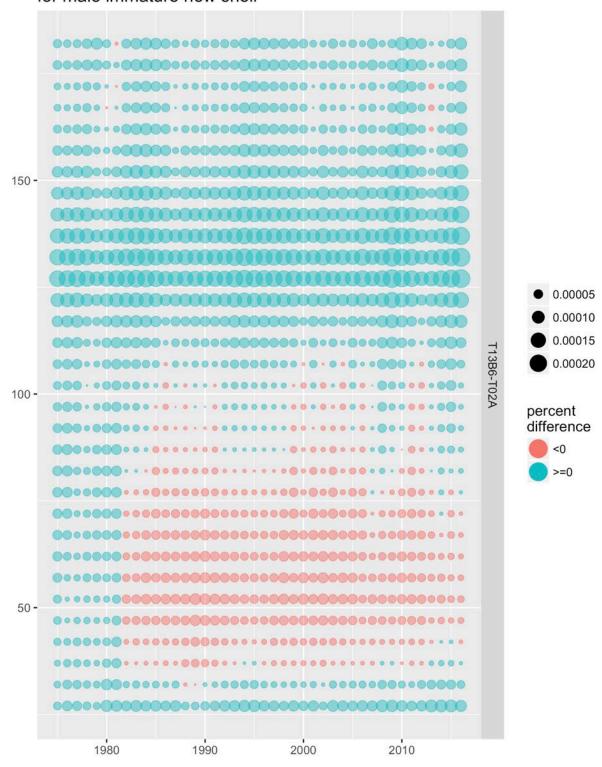


Figure 42. Differences for NMFS trawl survey survey abundance for male immature new shell.

## NMFS trawl survey survey abundance for male mature new shell

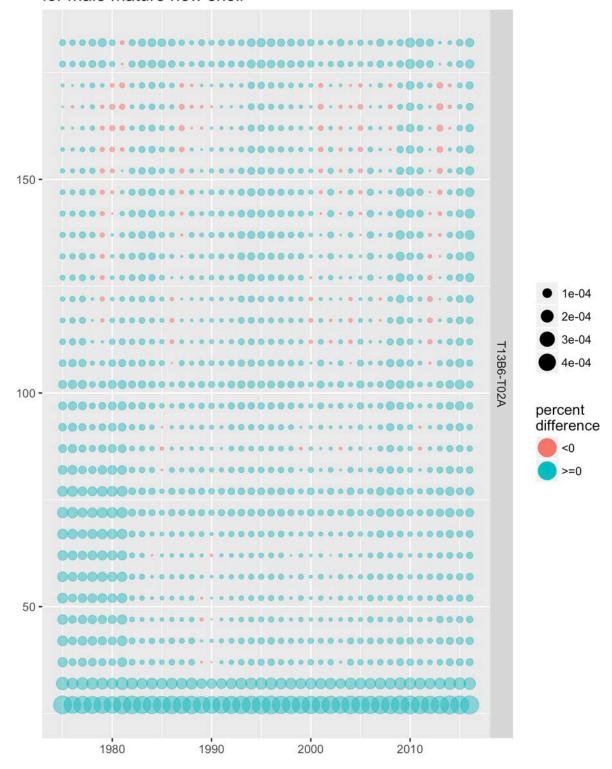


Figure 43. Differences for NMFS trawl survey survey abundance for male mature new shell.

## NMFS trawl survey survey abundance for male mature old shell

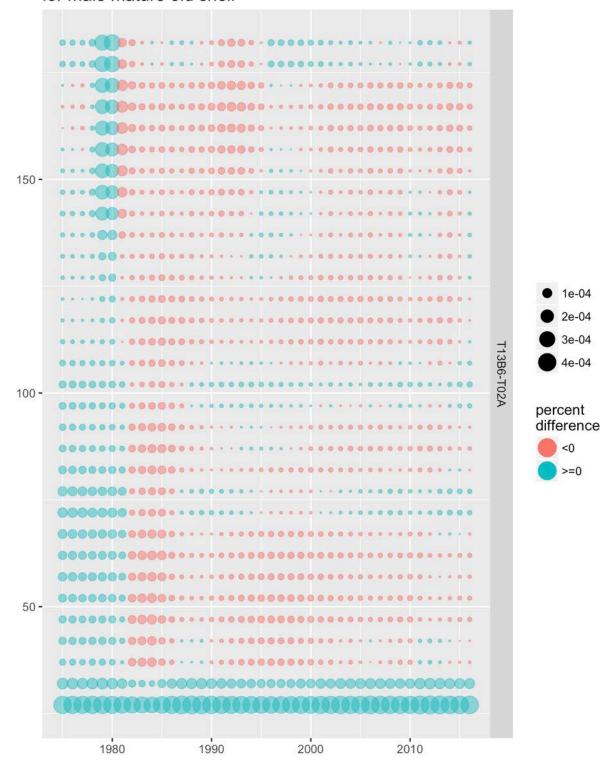


Figure 44. Differences for NMFS trawl survey survey abundance for male mature old shell.

## NMFS trawl survey survey abundance for female immature new shell

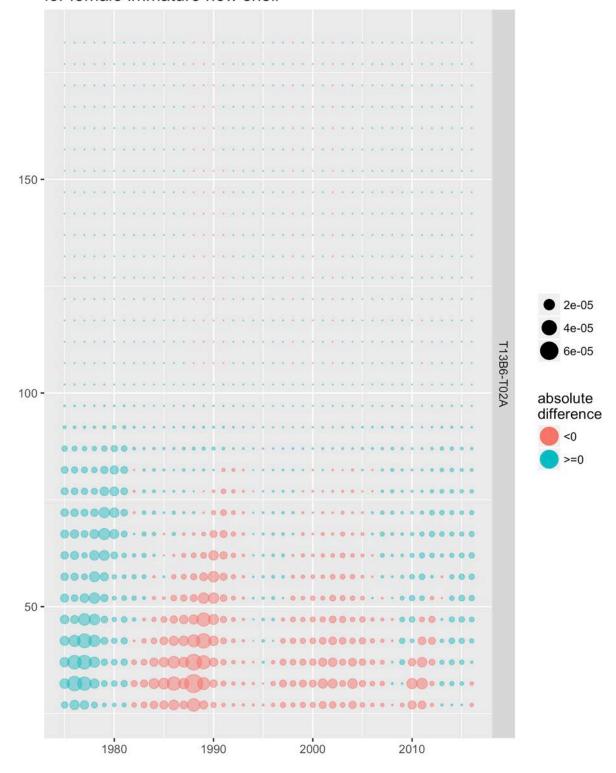


Figure 45. Differences for NMFS trawl survey survey abundance for female immature new shell.

## NMFS trawl survey survey abundance for female mature new shell

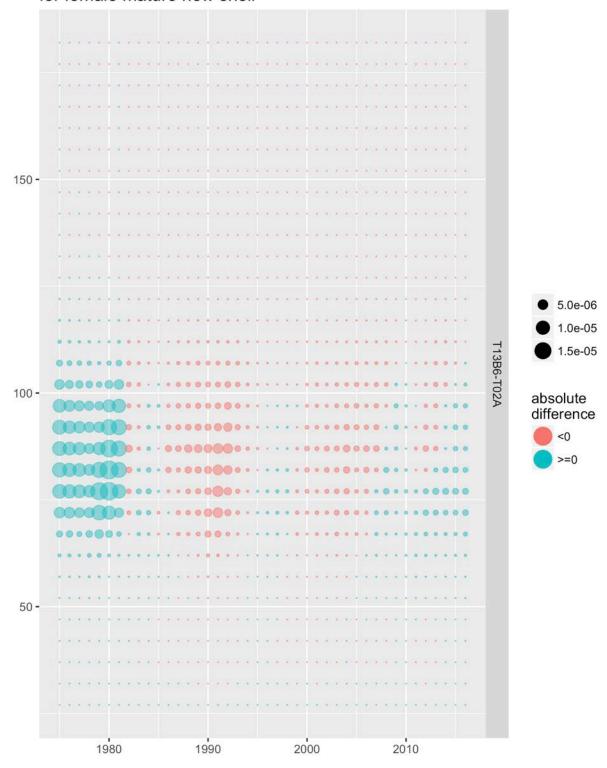


Figure 46. Differences for NMFS trawl survey survey abundance for female mature new shell.

## NMFS trawl survey survey abundance for female mature old shell

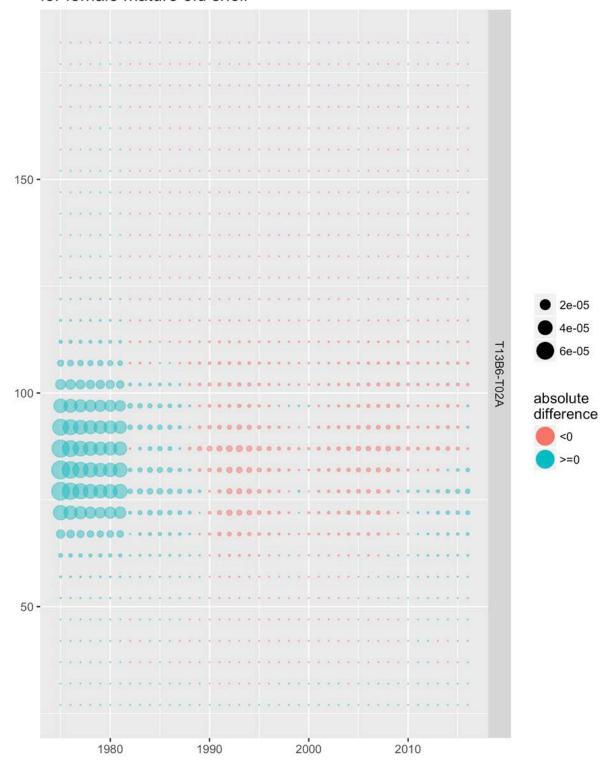


Figure 47. Differences for NMFS trawl survey survey abundance for female mature old shell.

## NMFS trawl survey survey abundance for male immature new shell

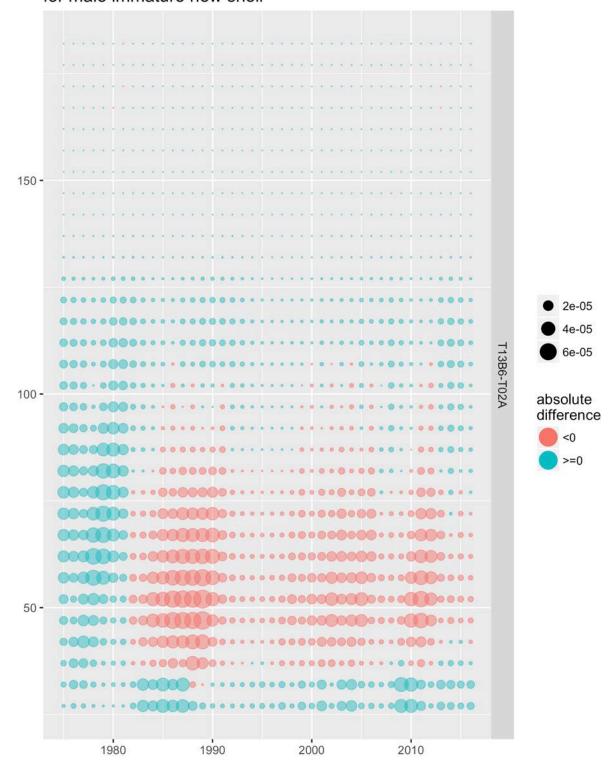


Figure 48. Differences for NMFS trawl survey survey abundance for male immature new shell.

## NMFS trawl survey survey abundance for male mature new shell

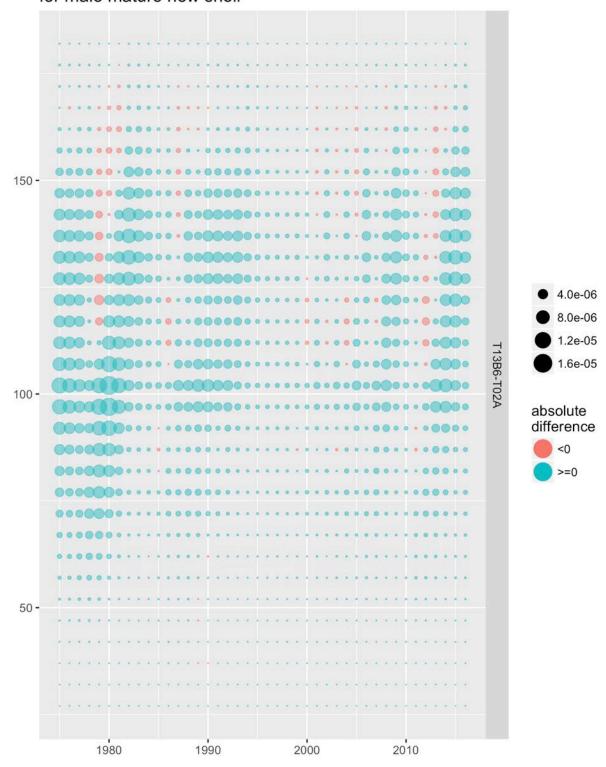


Figure 49. Differences for NMFS trawl survey survey abundance for male mature new shell.

## NMFS trawl survey survey abundance for male mature old shell

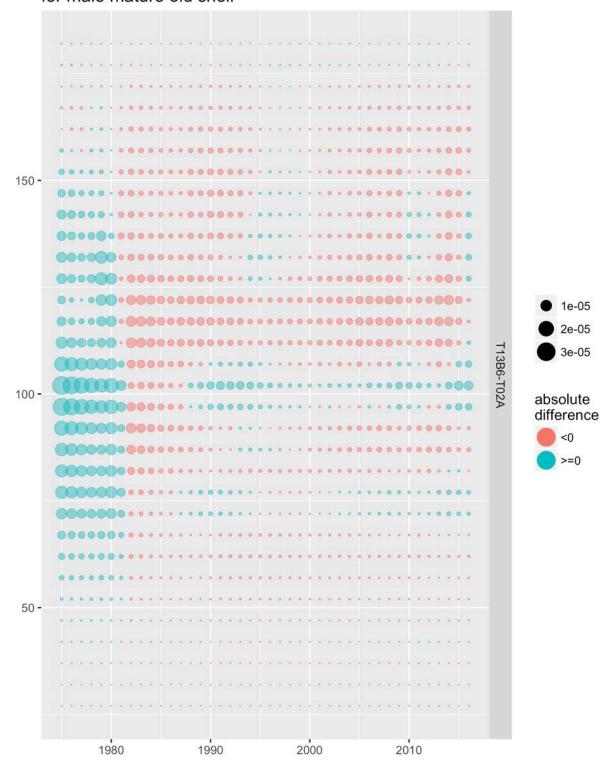


Figure 50. Differences for NMFS trawl survey survey abundance for male mature old shell.

#### **Survey biomass**

### NMFS trawl survey: survey biomass

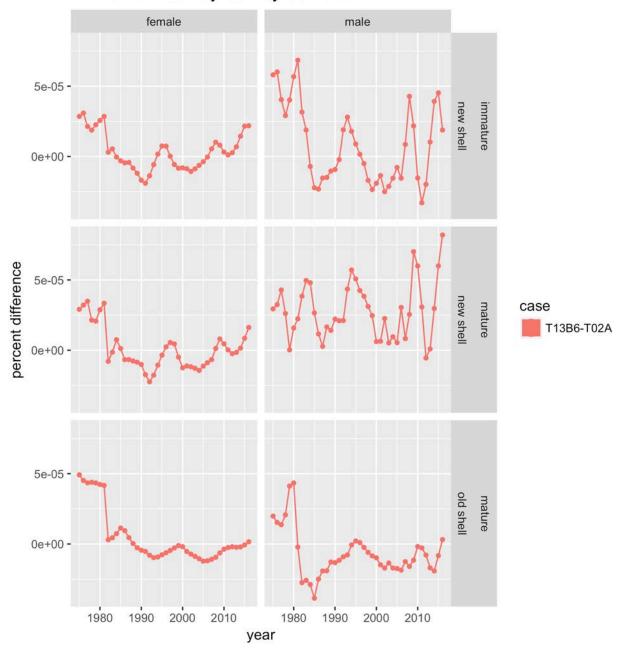


Figure 51. Differences for NMFS trawl survey: survey biomass.

### NMFS trawl survey: survey biomass

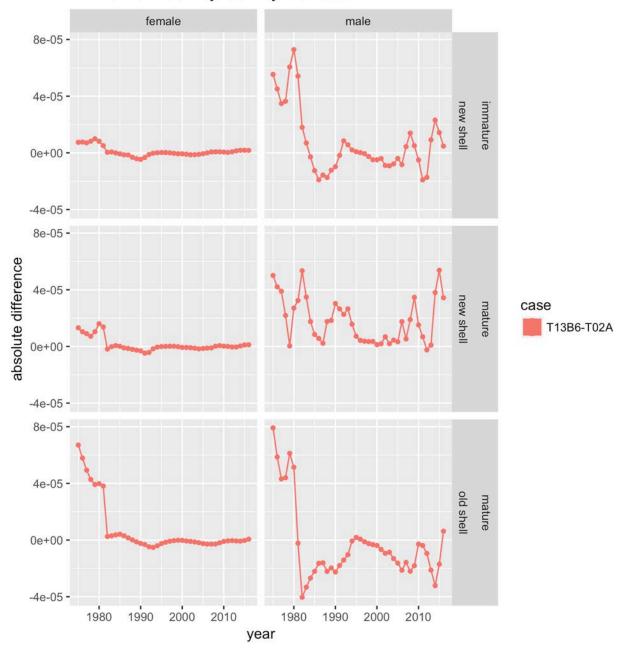


Figure 52. Differences for NMFS trawl survey: survey biomass.

#### Fisheries

#### Fishery catchability

#### TCF: fishery catchability

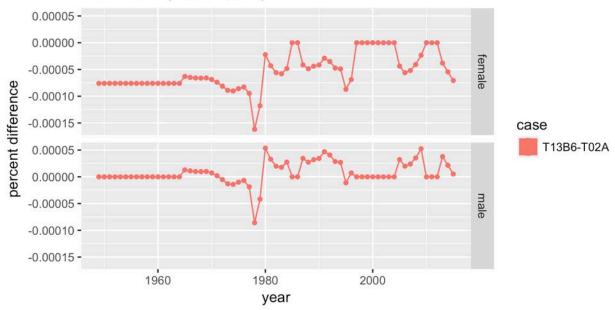


Figure 53. Differences for TCF: fishery catchability.

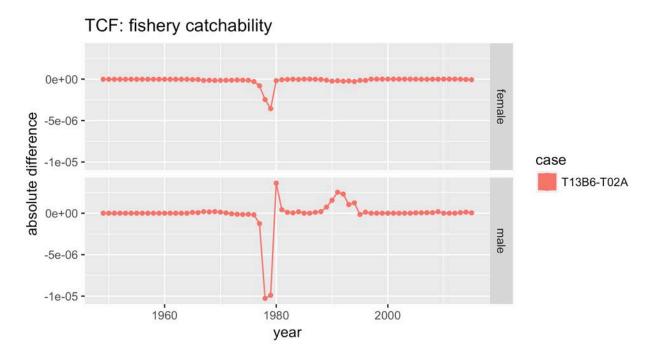


Figure 54. Differences for TCF: fishery catchability.

#### SCF: fishery catchability 2e-05 -0e+00 --2e-05 percent difference -4e-05 case T13B6-T02A 2e-05 -0e+00 -2e-05 --4e-05 **-**2000 1980 1960 year

Figure 55. Differences for SCF: fishery catchability.

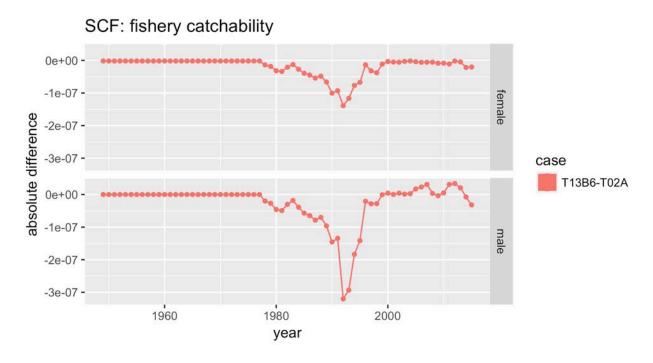


Figure 56. Differences for SCF: fishery catchability.

#### GTF: fishery catchability 5e-05 -0e+00 female percent difference -5e-05 case -1e-04 -T13B6-T02A 5e-05 -0e+00 male -5e-05 --1e-04 -1980 2000 1960 year

Figure 57. Differences for GTF: fishery catchability.

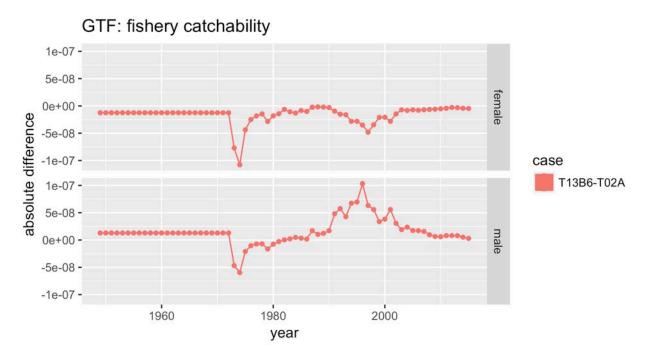


Figure 58. Differences for GTF: fishery catchability.

### RKF: fishery catchability

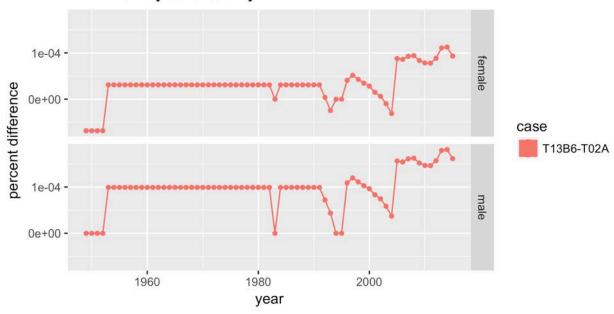


Figure 59. Differences for RKF: fishery catchability.

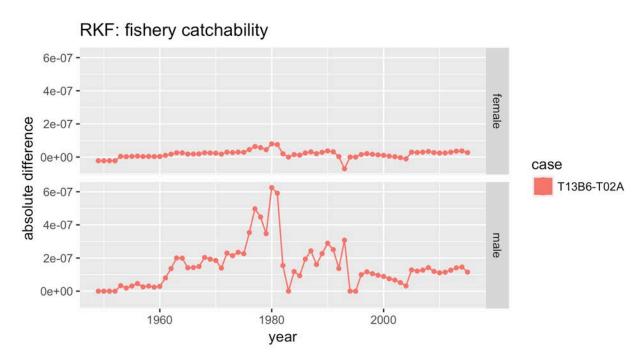


Figure 60. Differences for RKF: fishery catchability.

#### **Total selectivity functions**

## TCF fishery selectivity for female all maturity all shell

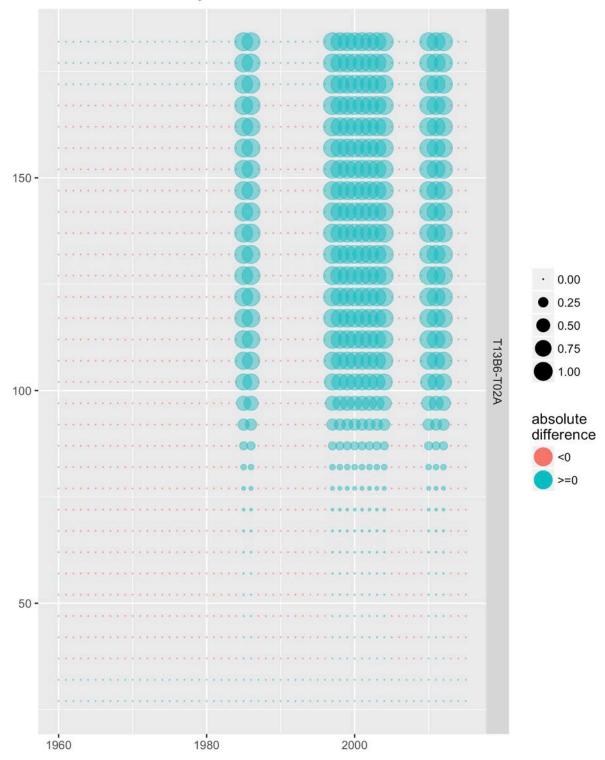


Figure 61. Differences for TCF fishery selectivity for female all maturity all shell.

# TCF fishery selectivity for male all maturity all shell

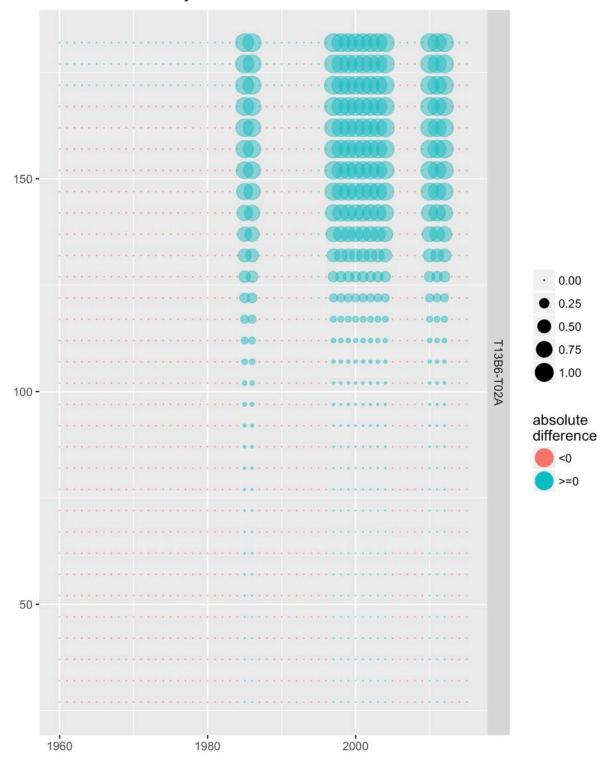


Figure 62. Differences for TCF fishery selectivity for male all maturity all shell.

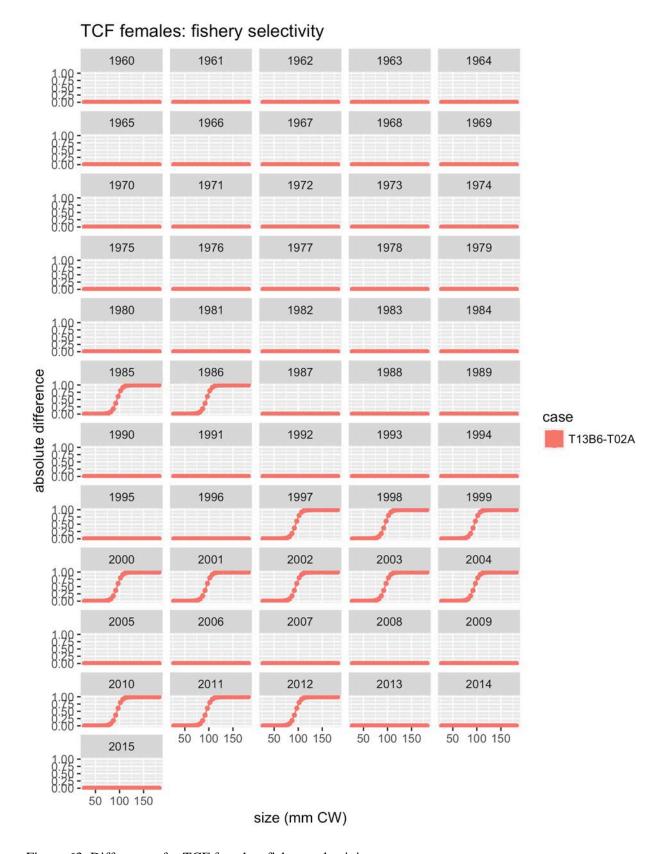


Figure 63. Differences for TCF females: fishery selectivity.

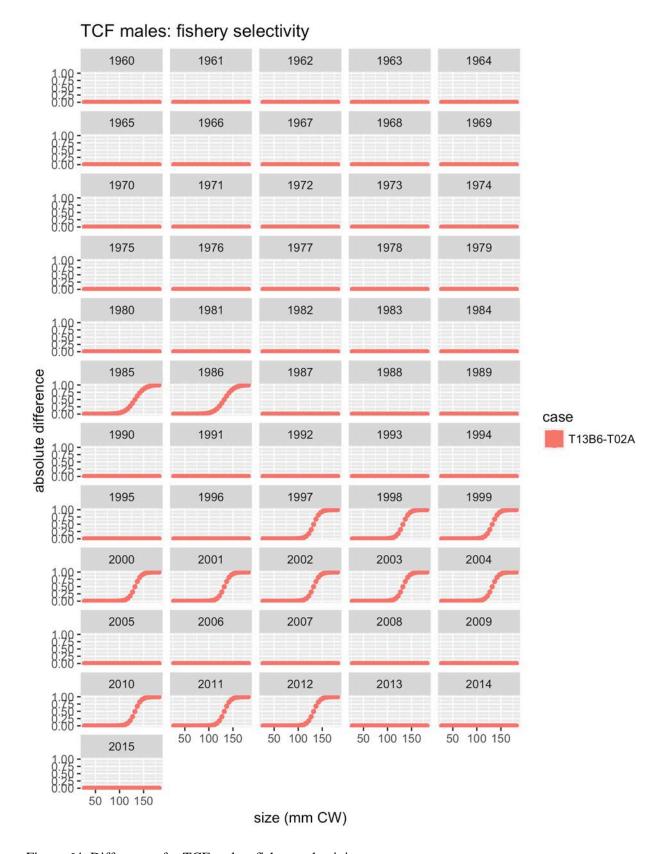


Figure 64. Differences for TCF males: fishery selectivity.

# SCF fishery selectivity for female all maturity all shell

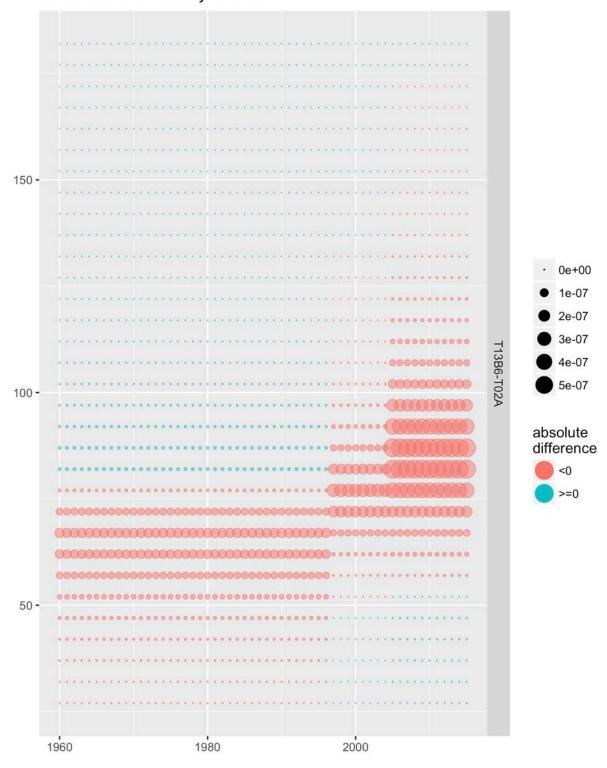


Figure 65. Differences for SCF fishery selectivity for female all maturity all shell.

# SCF fishery selectivity for male all maturity all shell

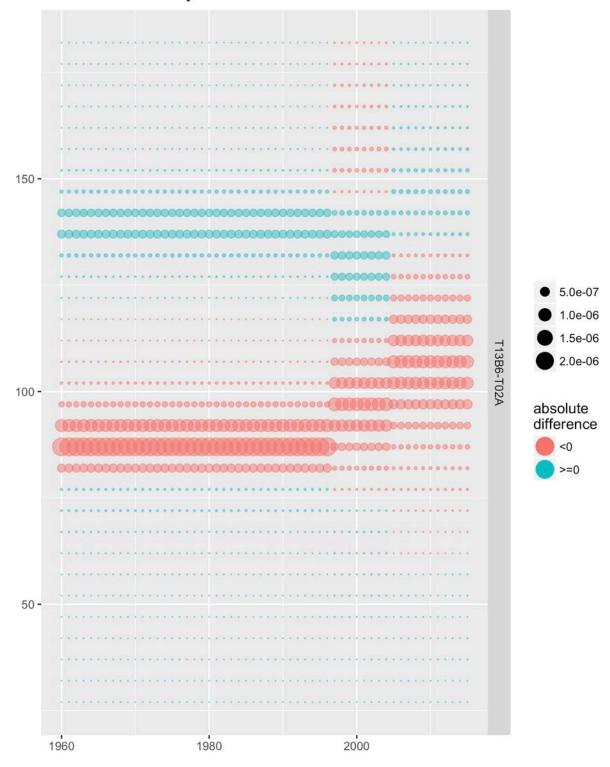


Figure 66. Differences for SCF fishery selectivity for male all maturity all shell.



Figure 67. Differences for SCF females: fishery selectivity.

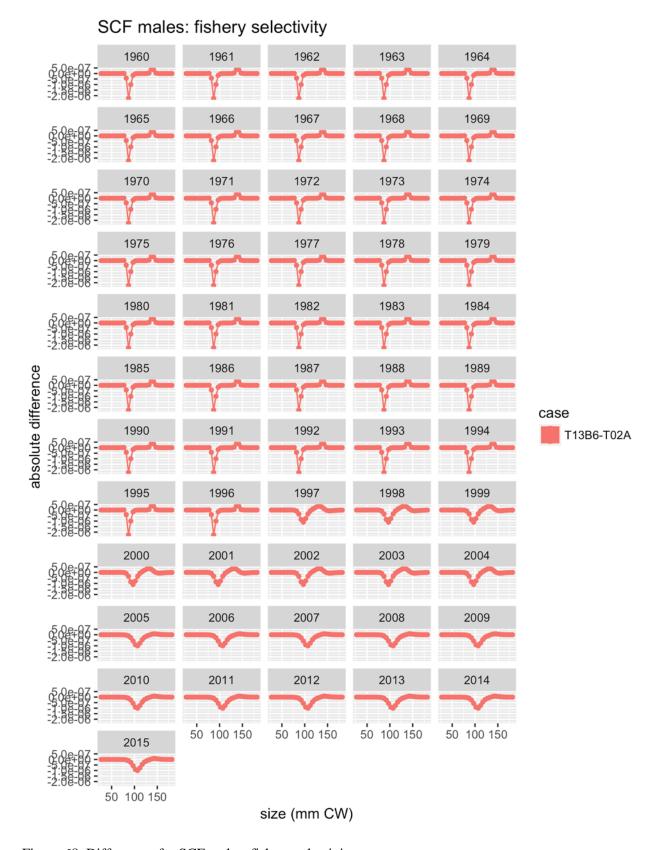


Figure 68. Differences for SCF males: fishery selectivity.

# GTF fishery selectivity for female all maturity all shell

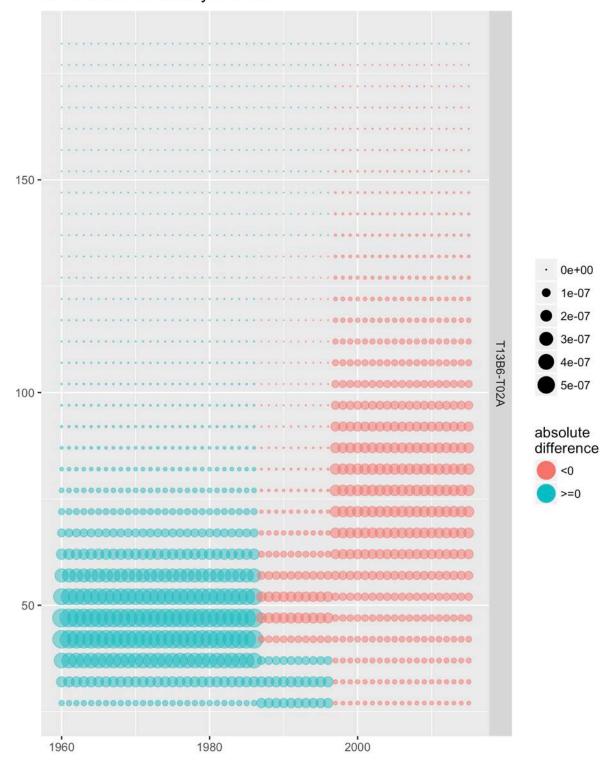


Figure 69. Differences for GTF fishery selectivity for female all maturity all shell.

# GTF fishery selectivity for male all maturity all shell

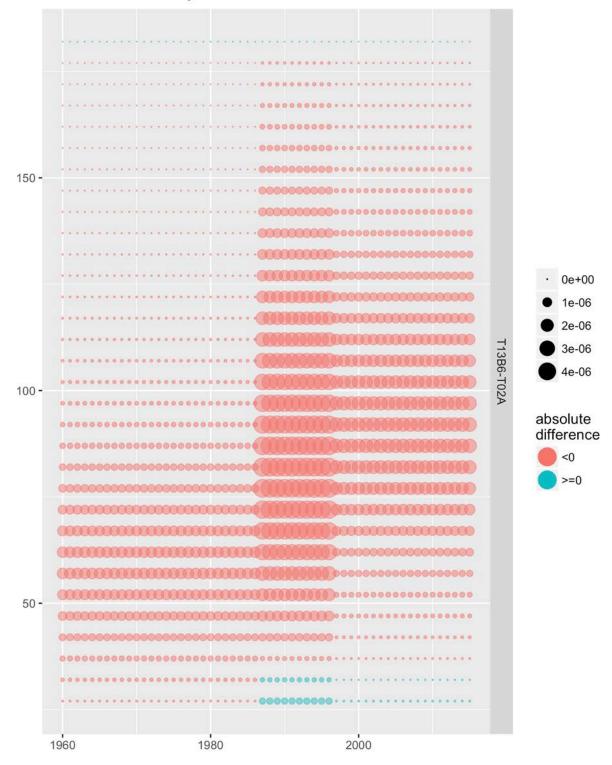


Figure 70. Differences for GTF fishery selectivity for male all maturity all shell.

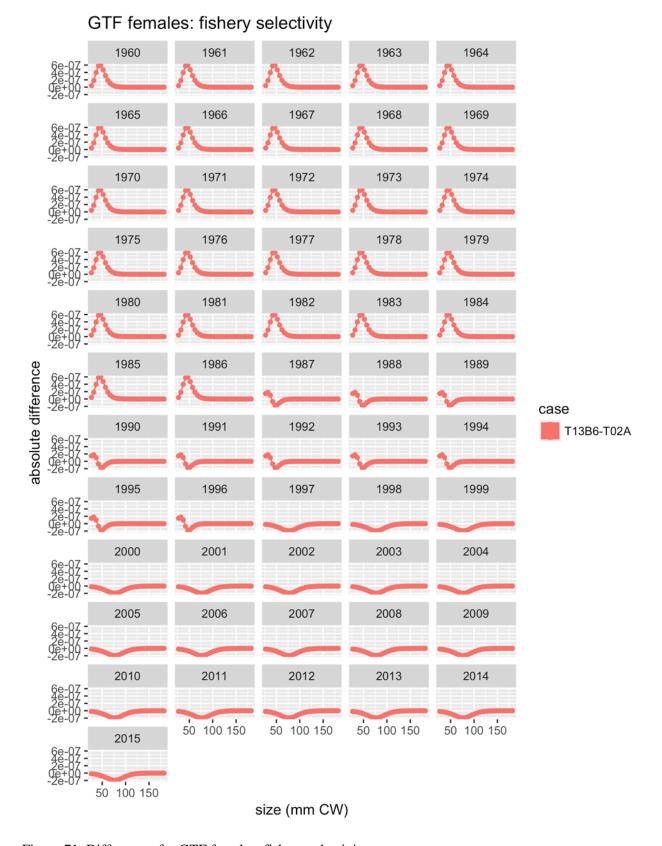


Figure 71. Differences for GTF females: fishery selectivity.

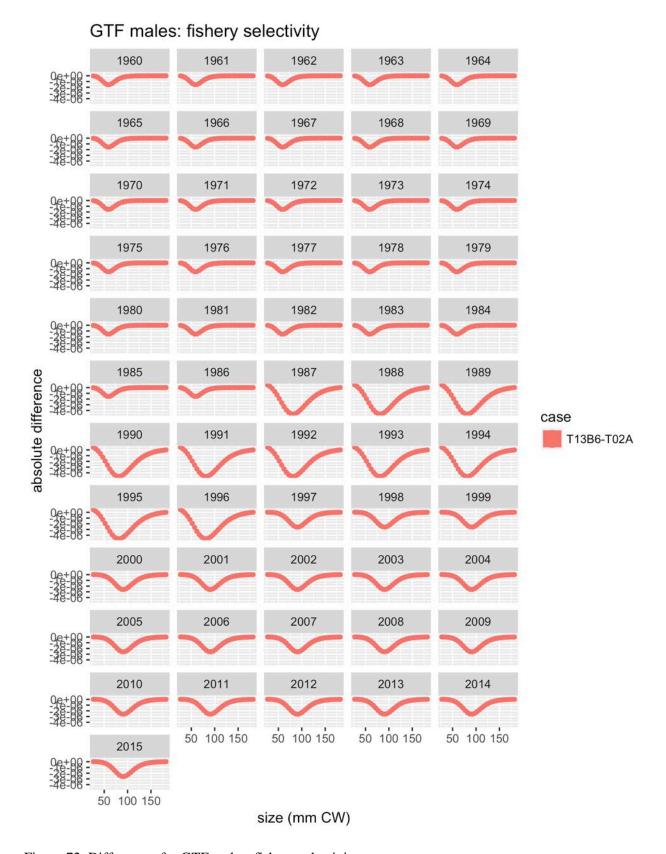


Figure 72. Differences for GTF males: fishery selectivity.

# RKF fishery selectivity for female all maturity all shell

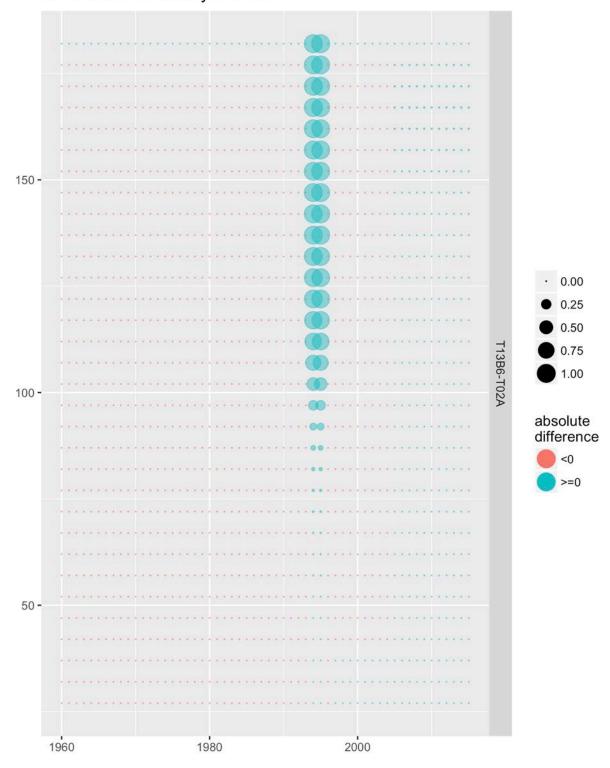


Figure 73. Differences for RKF fishery selectivity for female all maturity all shell.

# RKF fishery selectivity for male all maturity all shell

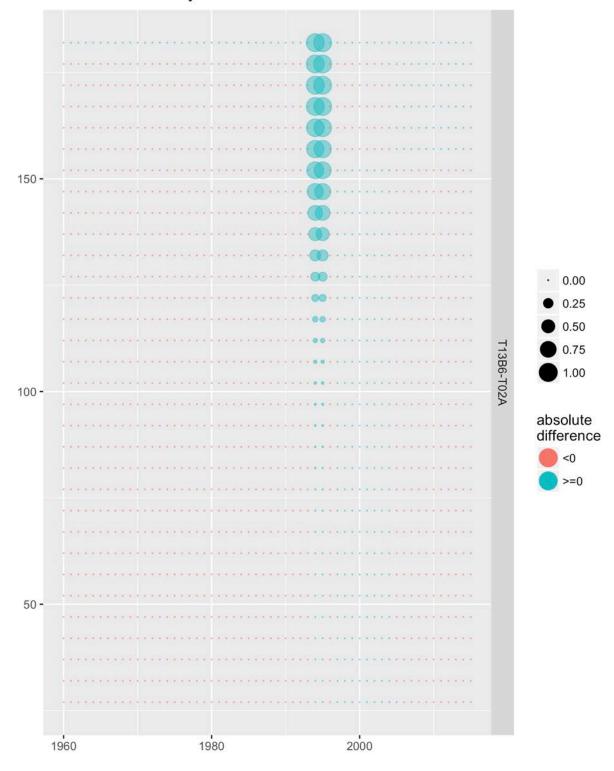


Figure 74. Differences for RKF fishery selectivity for male all maturity all shell.

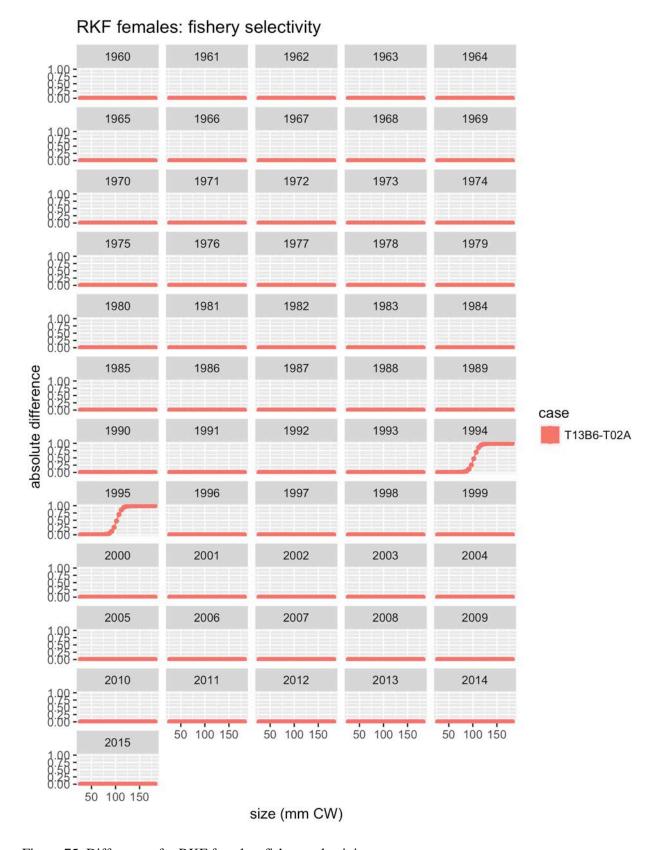


Figure 75. Differences for RKF females: fishery selectivity.

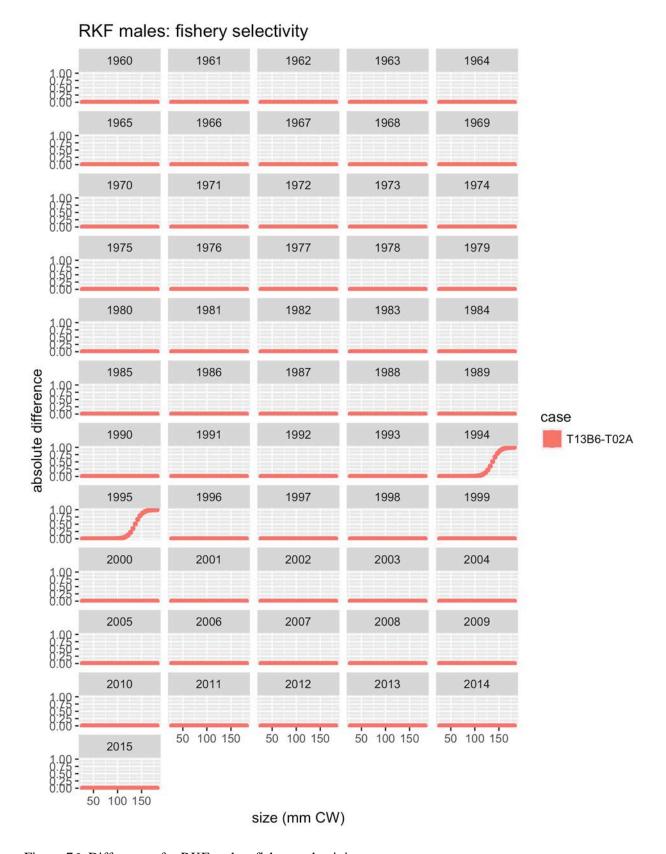


Figure 76. Differences for RKF males: fishery selectivity.

#### **Retention functions**

## TCF fishery retention for male all maturity all shell

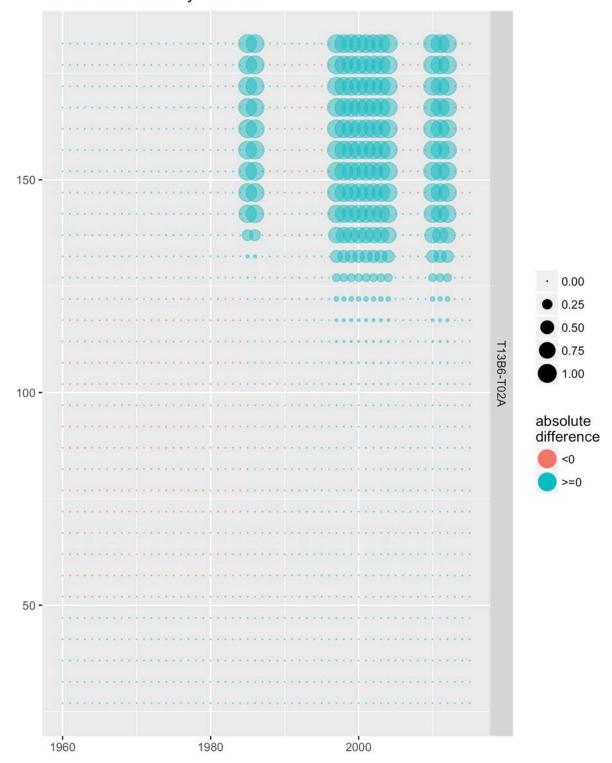


Figure 77. Differences for TCF fishery retention for male all maturity all shell.

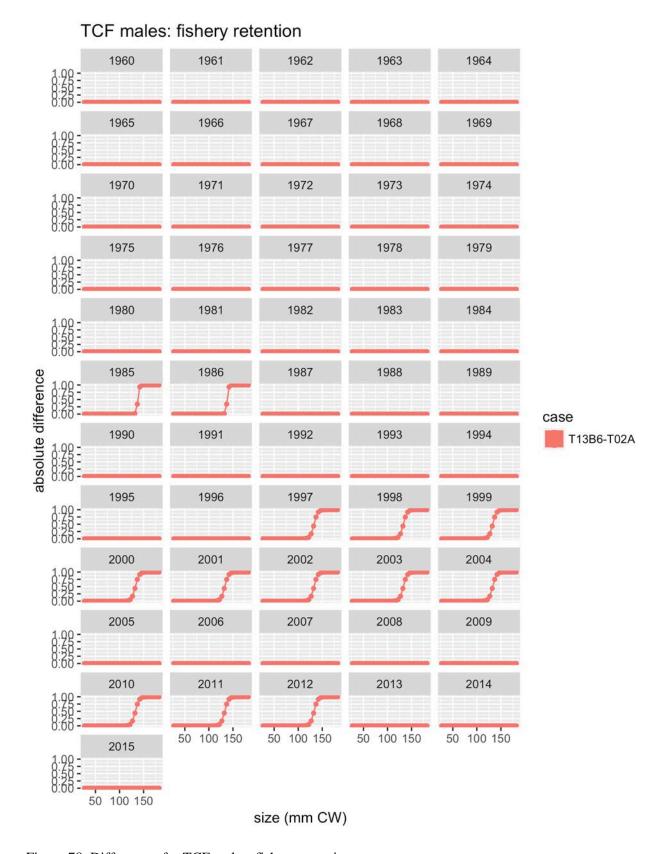


Figure 78. Differences for TCF males: fishery retention.

#### **Total catch abundance**

### TCF: fishery catch abundance

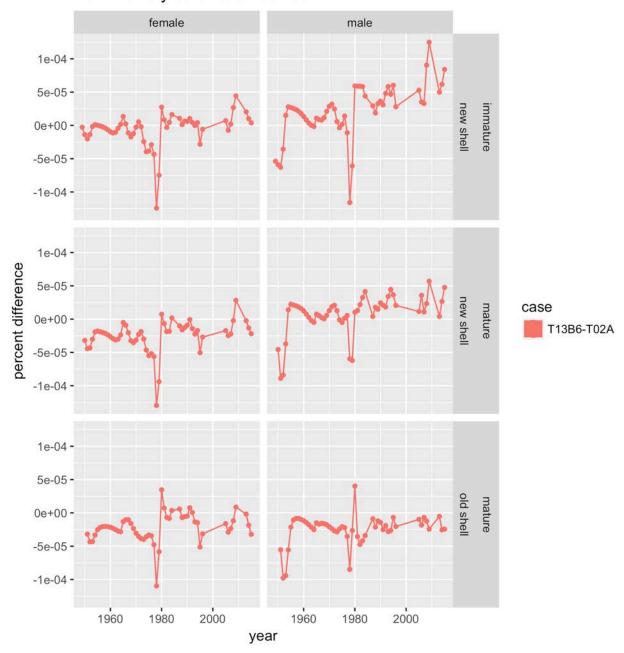


Figure 79. Differences for TCF: fishery catch abundance.

### TCF: fishery catch abundance

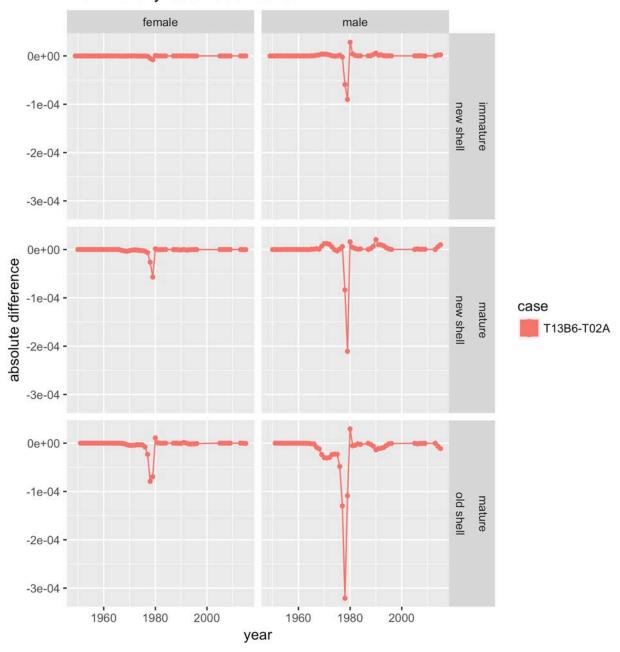


Figure 80. Differences for TCF: fishery catch abundance.

### SCF: fishery catch abundance

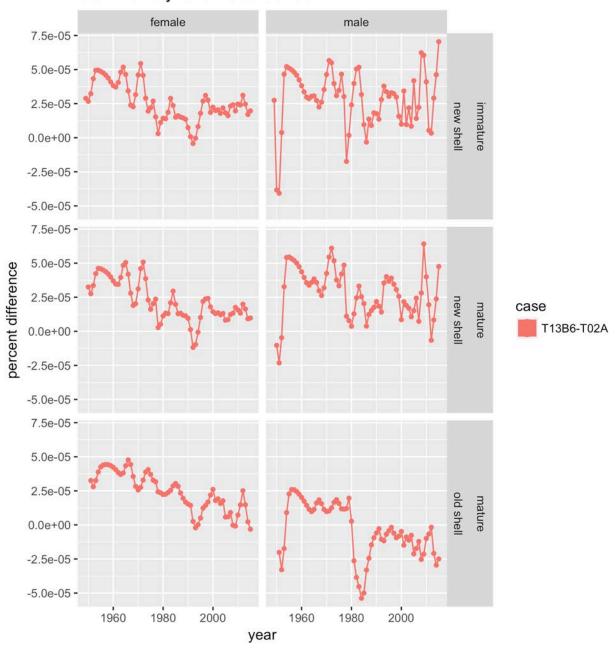


Figure 81. Differences for SCF: fishery catch abundance.

#### SCF: fishery catch abundance

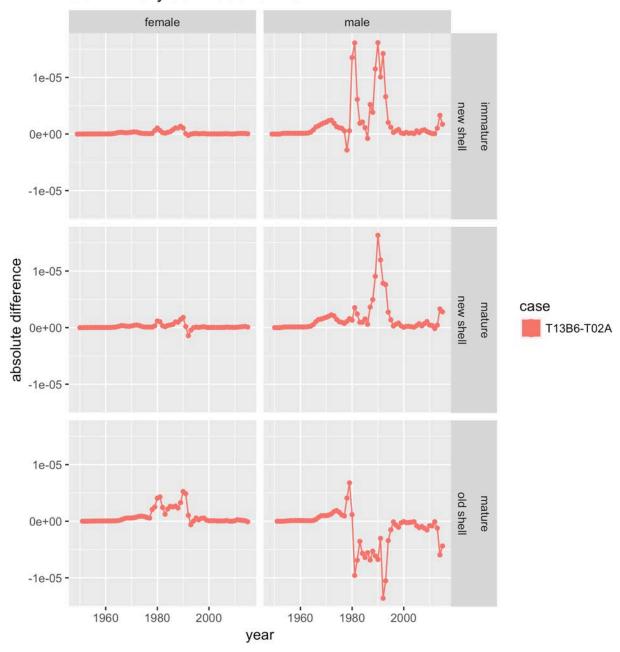


Figure 82. Differences for SCF: fishery catch abundance.

#### GTF: fishery catch abundance

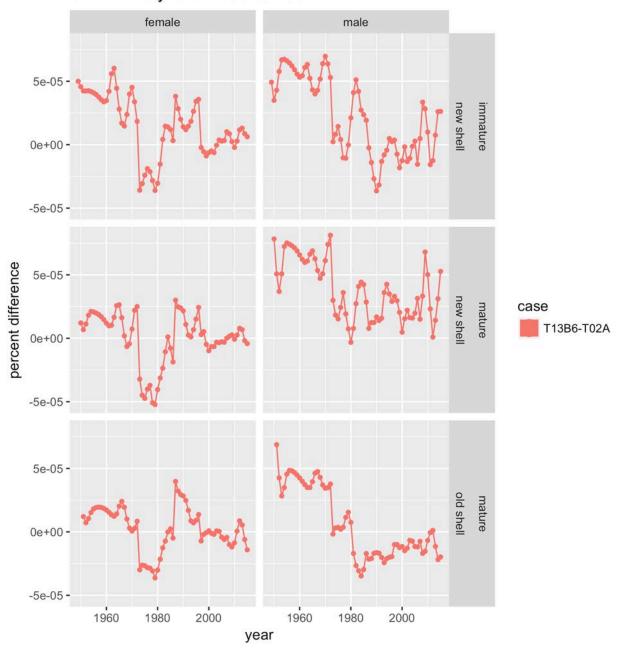


Figure 83. Differences for GTF: fishery catch abundance.

#### GTF: fishery catch abundance

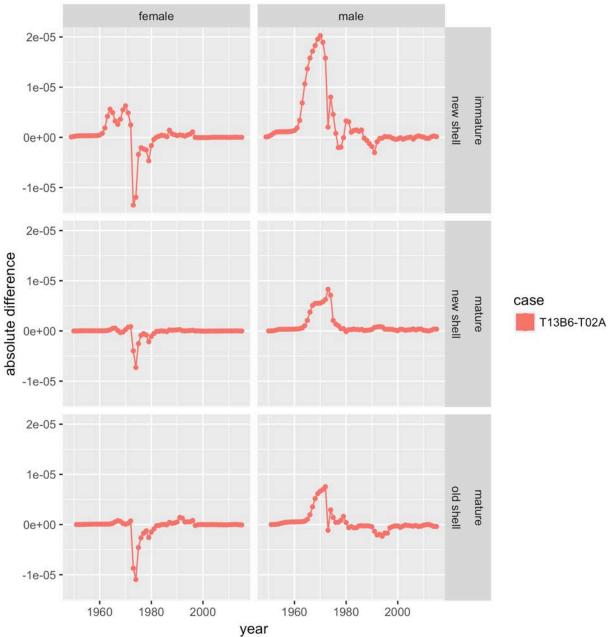


Figure 84. Differences for GTF: fishery catch abundance.

#### RKF: fishery catch abundance

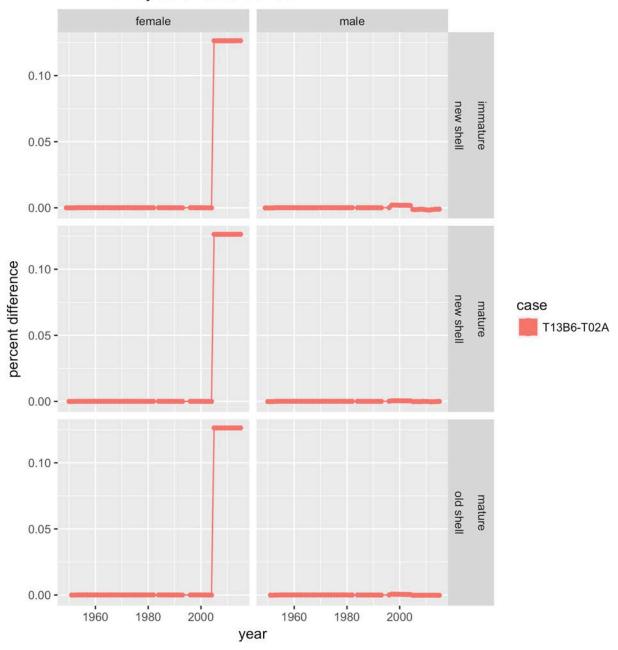


Figure 85. Differences for RKF: fishery catch abundance.

#### RKF: fishery catch abundance

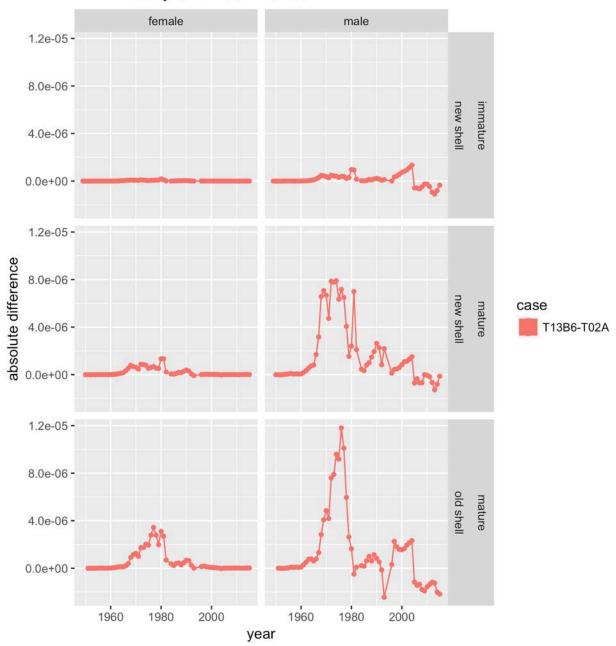


Figure 86. Differences for RKF: fishery catch abundance.

#### TCF fishery catch abundance for female immature new shell

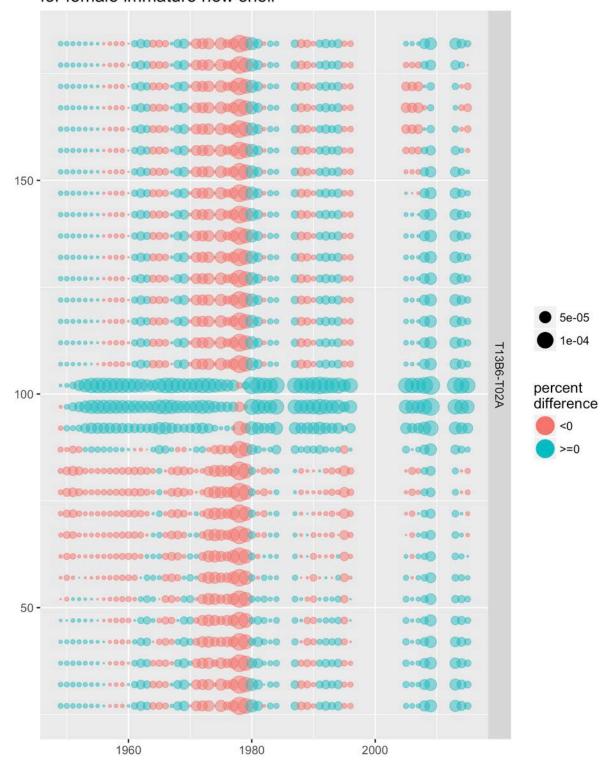


Figure 87. Differences for TCF fishery catch abundance for female immature new shell.

#### TCF fishery catch abundance for female mature new shell 150 -000 000 000000 000 G00000 000 0.00005 000 600000 0.00010 00000 000 T13B6-T02A 0.00015 00000 000 00000000000 00000 000 100 percent 000--00 difference 0000 - 000000 080-0 .00 <0 999.0 000 >=0 00000 .... 0 . 00 000 50 -

Figure 88. Differences for TCF fishery catch abundance for female mature new shell.

1980

1960

2000

#### TCF fishery catch abundance for female mature old shell

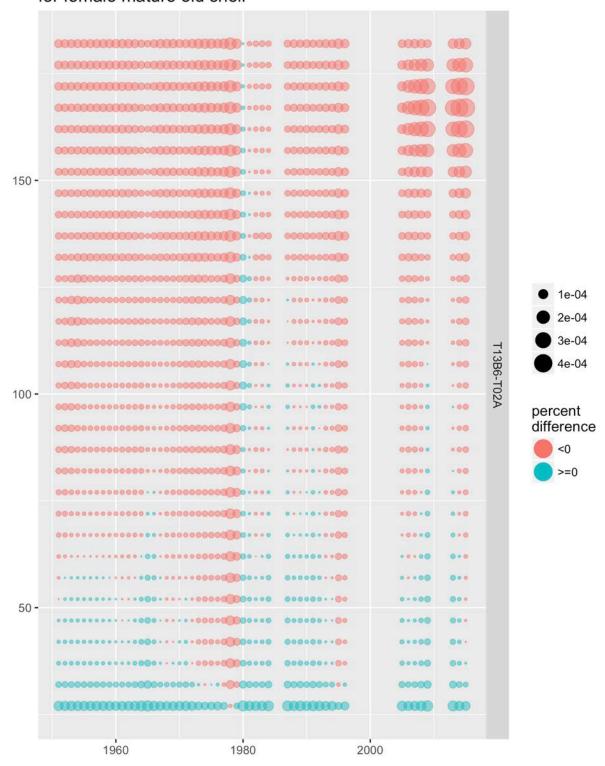


Figure 89. Differences for TCF fishery catch abundance for female mature old shell.

### TCF fishery catch abundance for male immature new shell

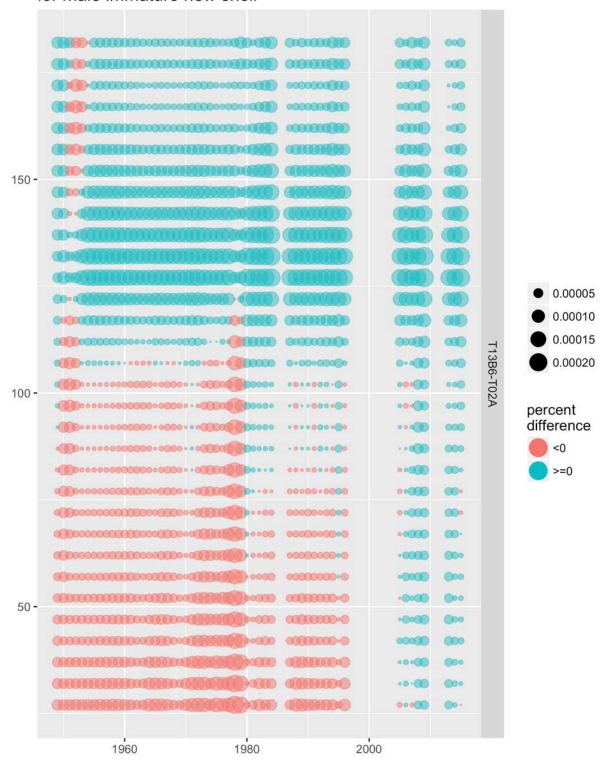


Figure 90. Differences for TCF fishery catch abundance for male immature new shell.

#### TCF fishery catch abundance for male mature new shell

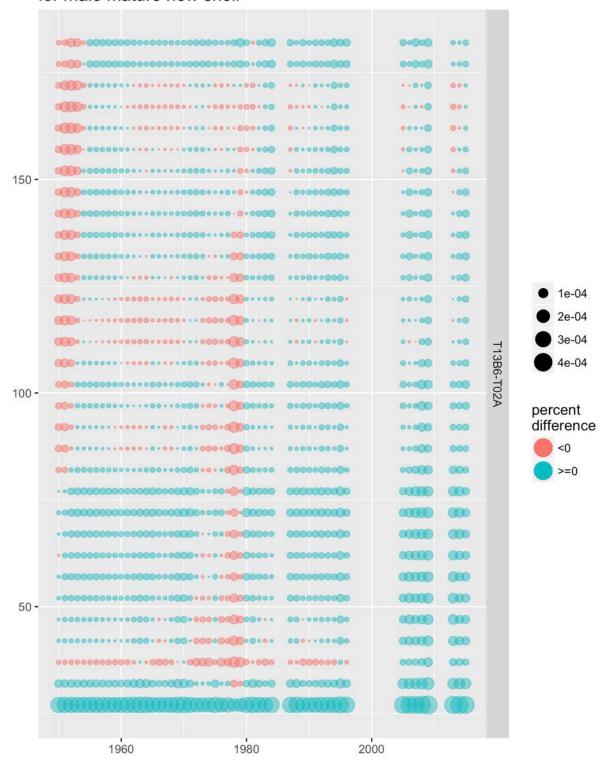


Figure 91. Differences for TCF fishery catch abundance for male mature new shell.

#### TCF fishery catch abundance for male mature old shell

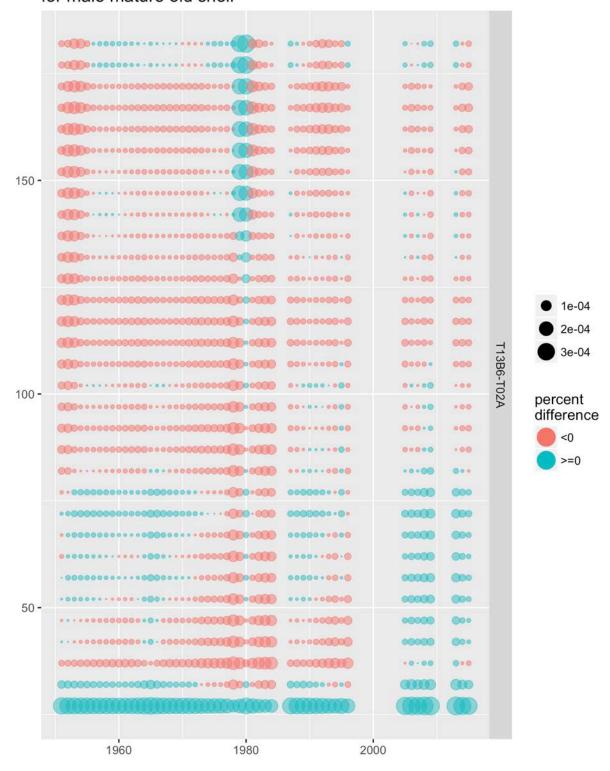


Figure 92. Differences for TCF fishery catch abundance for male mature old shell.

#### TCF fishery catch abundance for female immature new shell

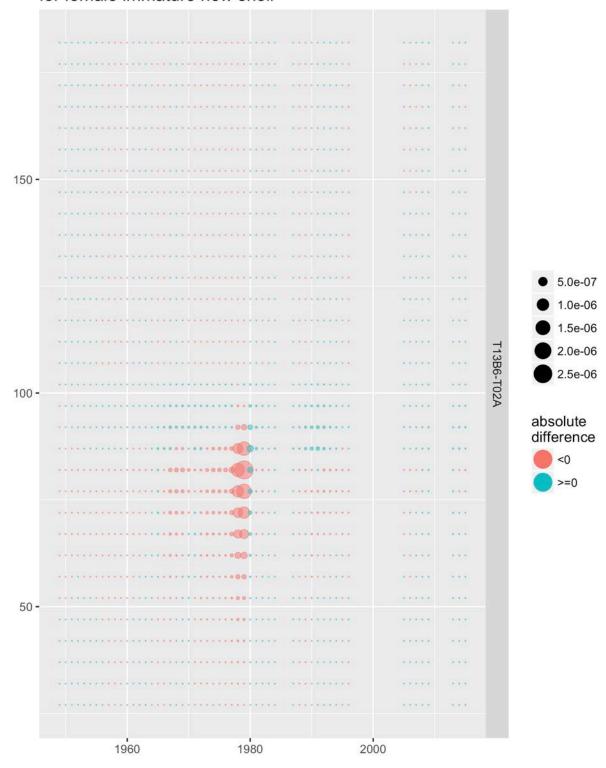


Figure 93. Differences for TCF fishery catch abundance for female immature new shell.

#### TCF fishery catch abundance for female mature new shell

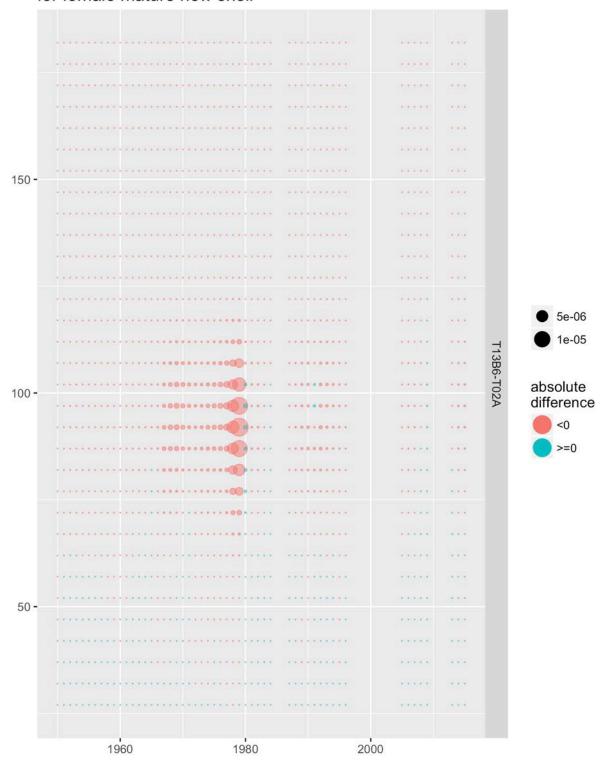


Figure 94. Differences for TCF fishery catch abundance for female mature new shell.

#### TCF fishery catch abundance for female mature old shell

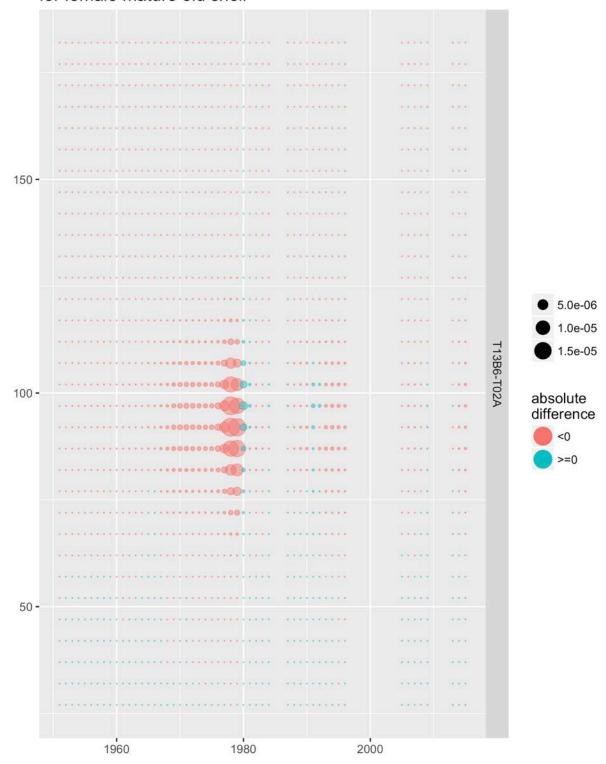


Figure 95. Differences for TCF fishery catch abundance for female mature old shell.

#### TCF fishery catch abundance for male immature new shell

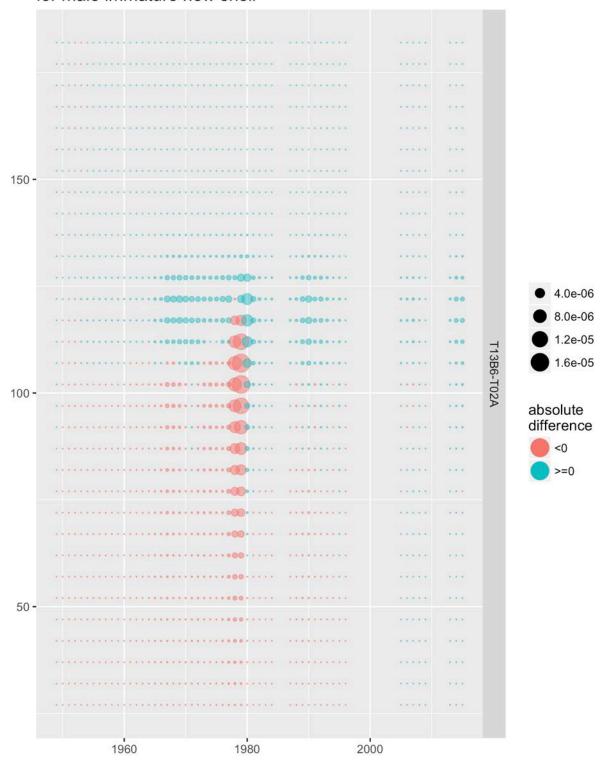


Figure 96. Differences for TCF fishery catch abundance for male immature new shell.

#### TCF fishery catch abundance for male mature new shell

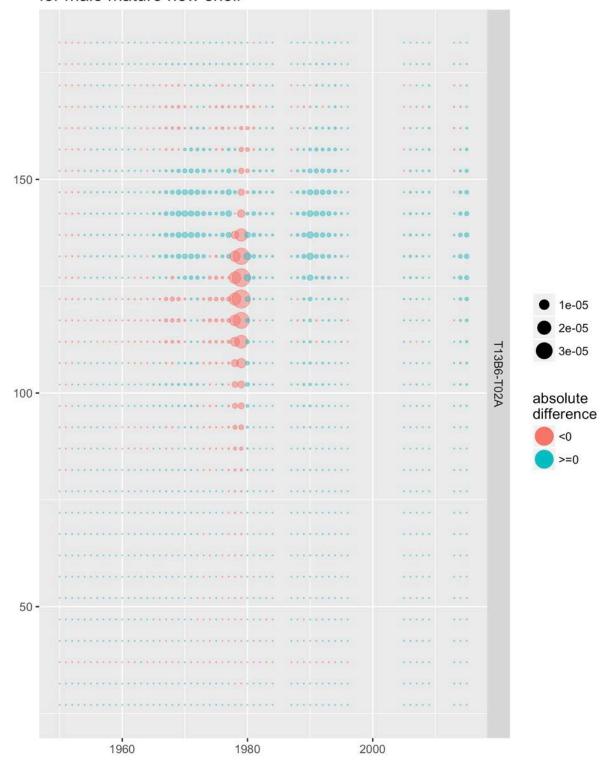


Figure 97. Differences for TCF fishery catch abundance for male mature new shell.

### TCF fishery catch abundance for male mature old shell

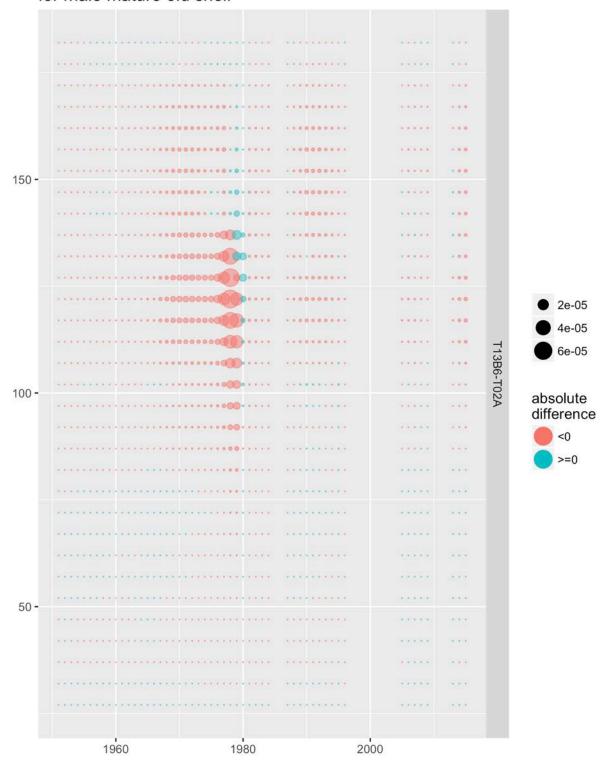


Figure 98. Differences for TCF fishery catch abundance for male mature old shell.

## SCF fishery catch abundance for female immature new shell

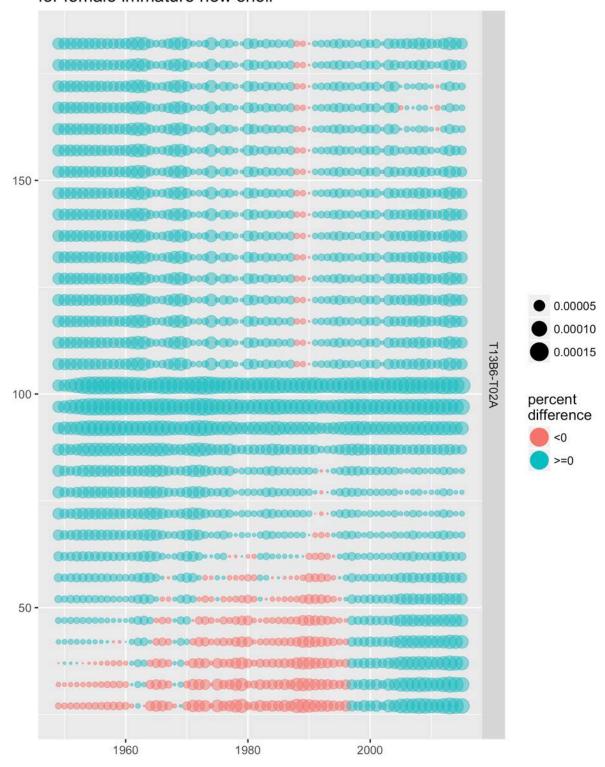


Figure 99. Differences for SCF fishery catch abundance for female immature new shell.

#### SCF fishery catch abundance for female mature new shell

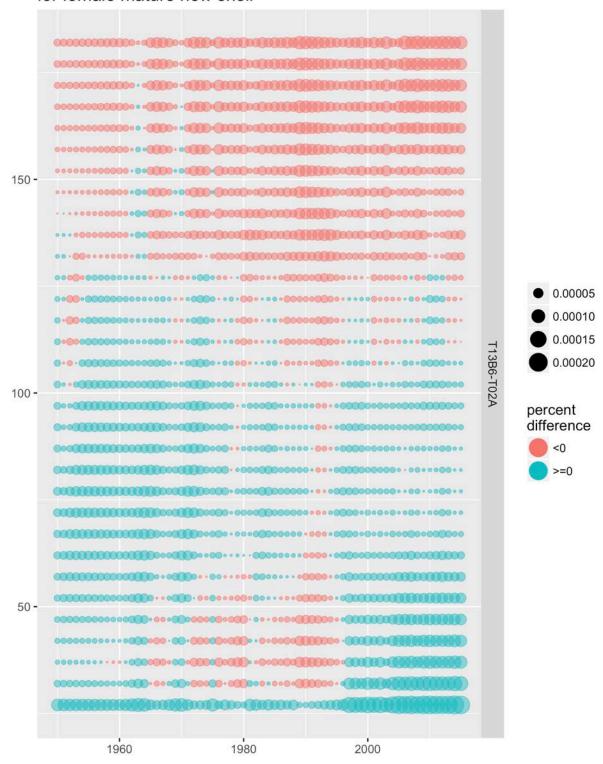


Figure 100. Differences for SCF fishery catch abundance for female mature new shell.

### SCF fishery catch abundance for female mature old shell

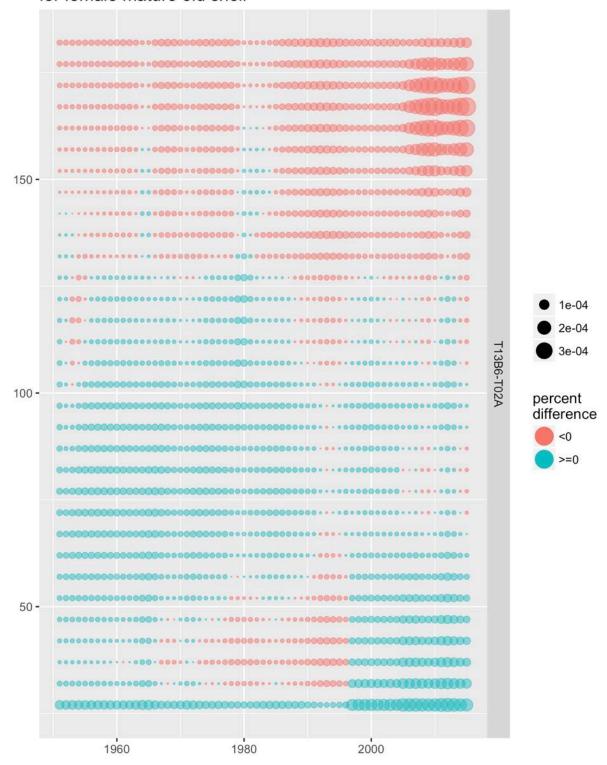


Figure 101. Differences for SCF fishery catch abundance for female mature old shell.

## SCF fishery catch abundance for male immature new shell

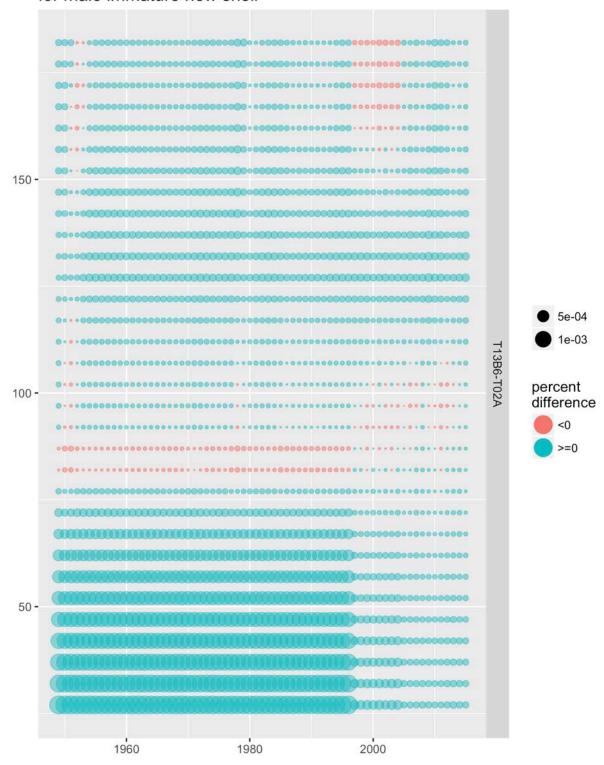


Figure 102. Differences for SCF fishery catch abundance for male immature new shell.

### SCF fishery catch abundance for male mature new shell

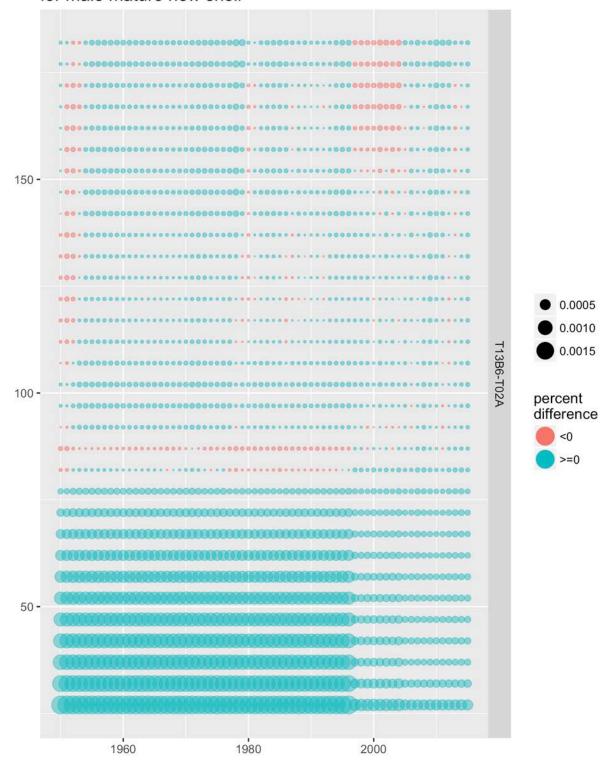


Figure 103. Differences for SCF fishery catch abundance for male mature new shell.

## SCF fishery catch abundance for male mature old shell

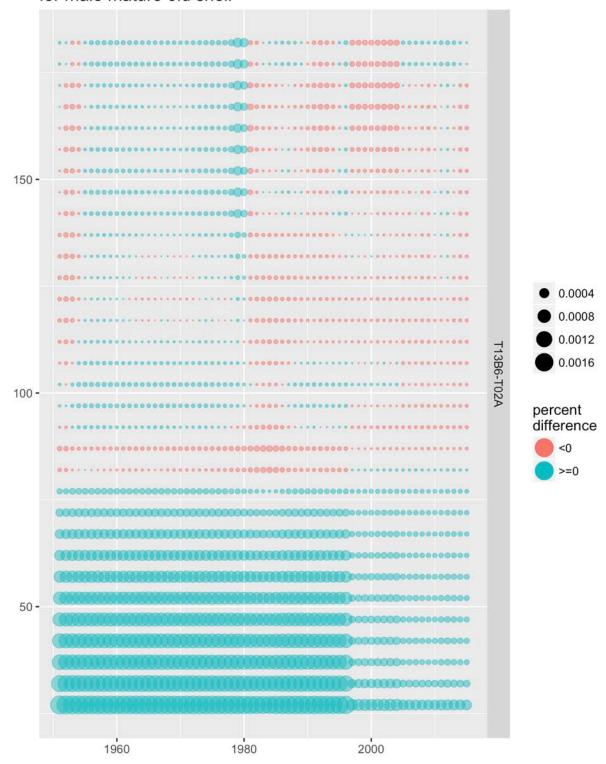


Figure 104. Differences for SCF fishery catch abundance for male mature old shell.

## SCF fishery catch abundance for female immature new shell

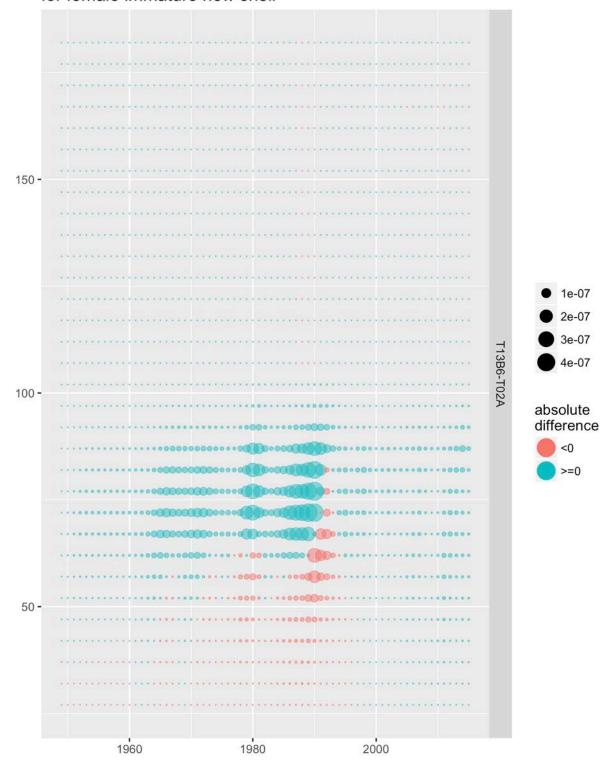


Figure 105. Differences for SCF fishery catch abundance for female immature new shell.

## SCF fishery catch abundance for female mature new shell

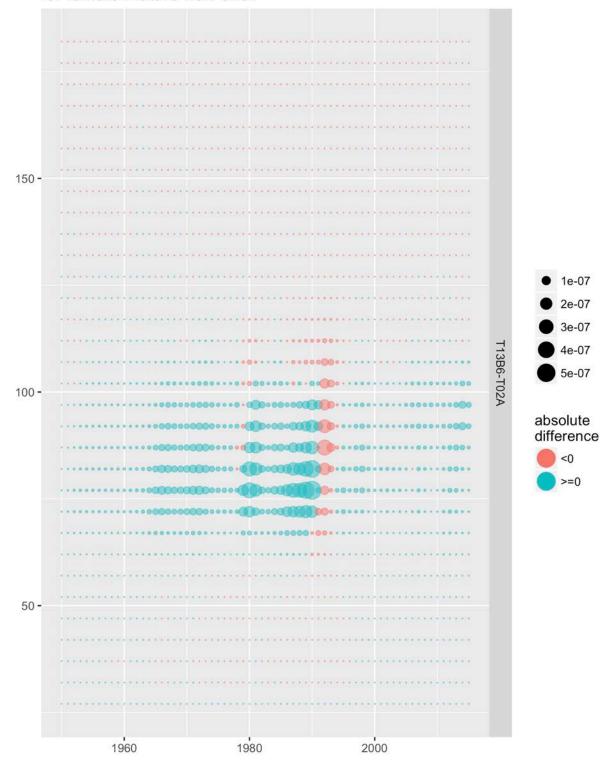


Figure 106. Differences for SCF fishery catch abundance for female mature new shell.

## SCF fishery catch abundance for female mature old shell

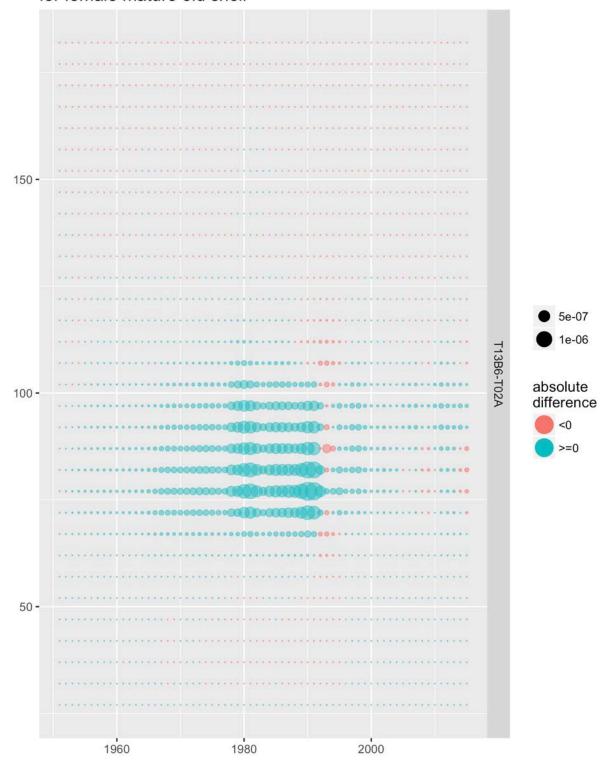


Figure 107. Differences for SCF fishery catch abundance for female mature old shell.

### SCF fishery catch abundance for male immature new shell

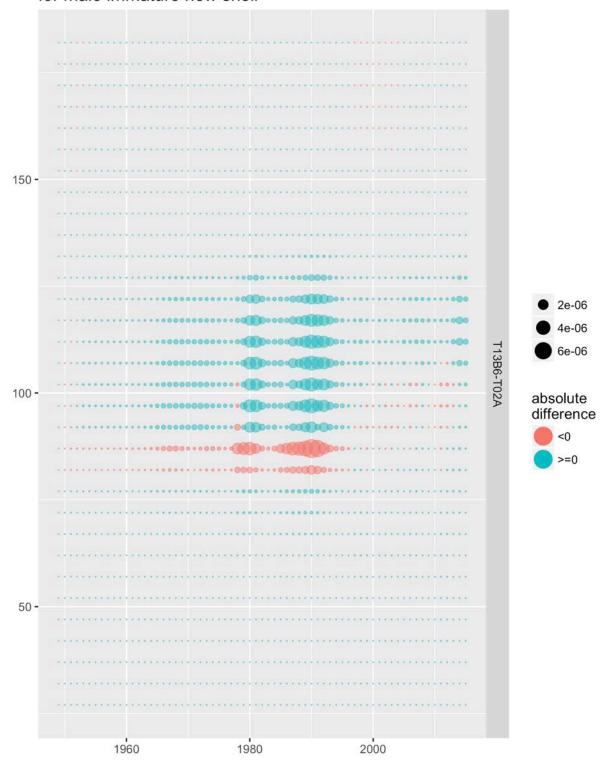


Figure 108. Differences for SCF fishery catch abundance for male immature new shell.

## SCF fishery catch abundance for male mature new shell

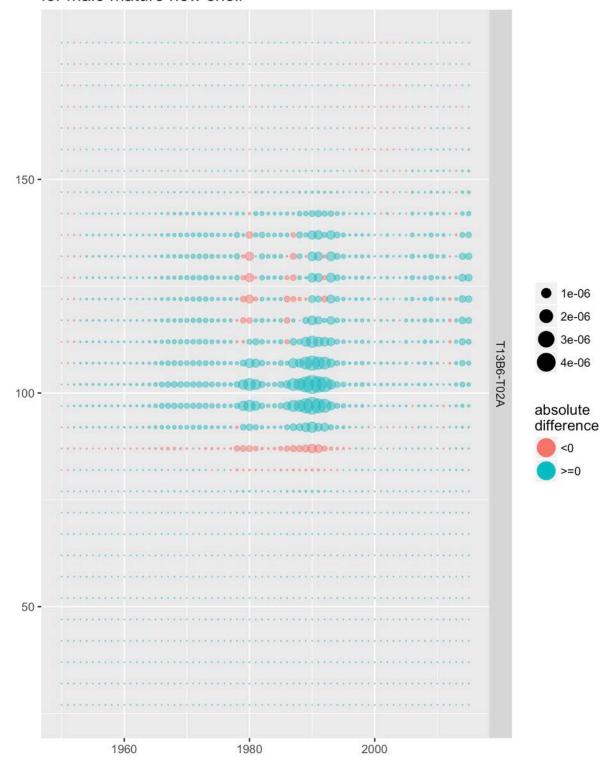


Figure 109. Differences for SCF fishery catch abundance for male mature new shell.

## SCF fishery catch abundance for male mature old shell

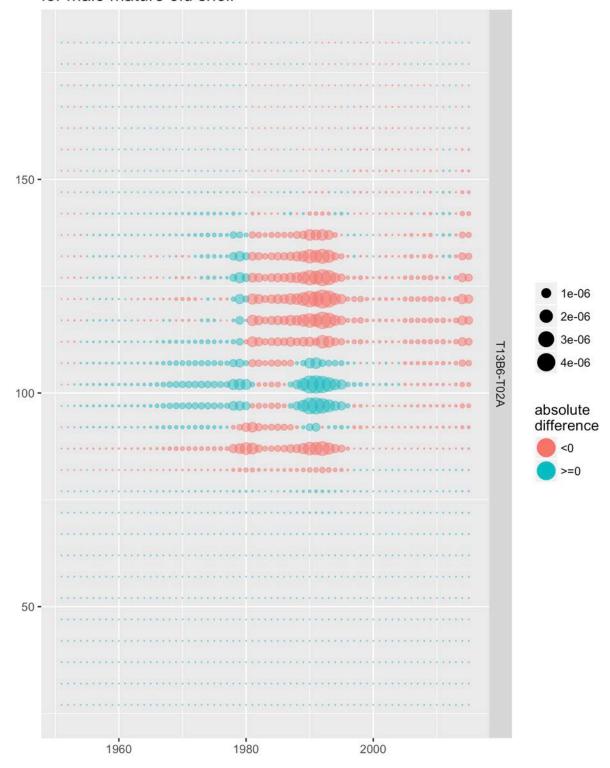


Figure 110. Differences for SCF fishery catch abundance for male mature old shell.

## GTF fishery catch abundance for female immature new shell

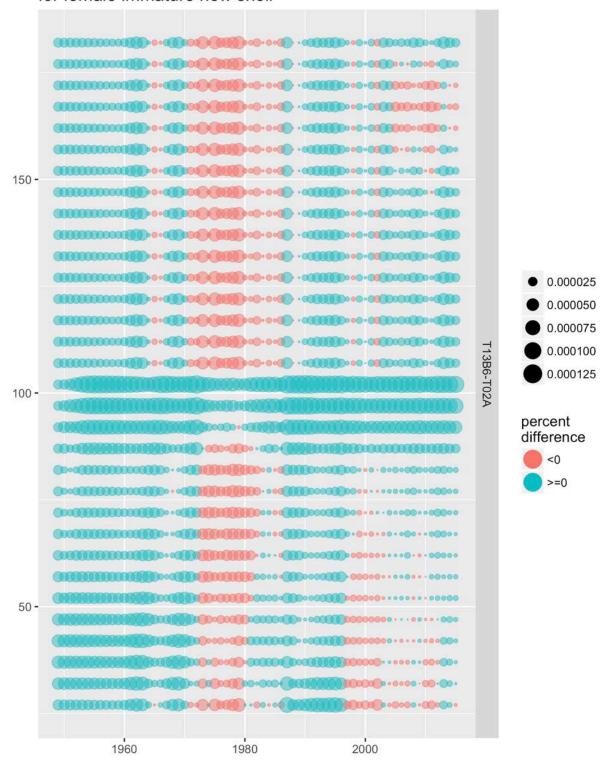


Figure 111. Differences for GTF fishery catch abundance for female immature new shell.

# GTF fishery catch abundance for female mature new shell 150 -0.00005 0.00010 T13B6-T02A 0.00015 100 percent difference <0 >=0

Figure 112. Differences for GTF fishery catch abundance for female mature new shell.

1980

2000

50 -

1960

### GTF fishery catch abundance for female mature old shell

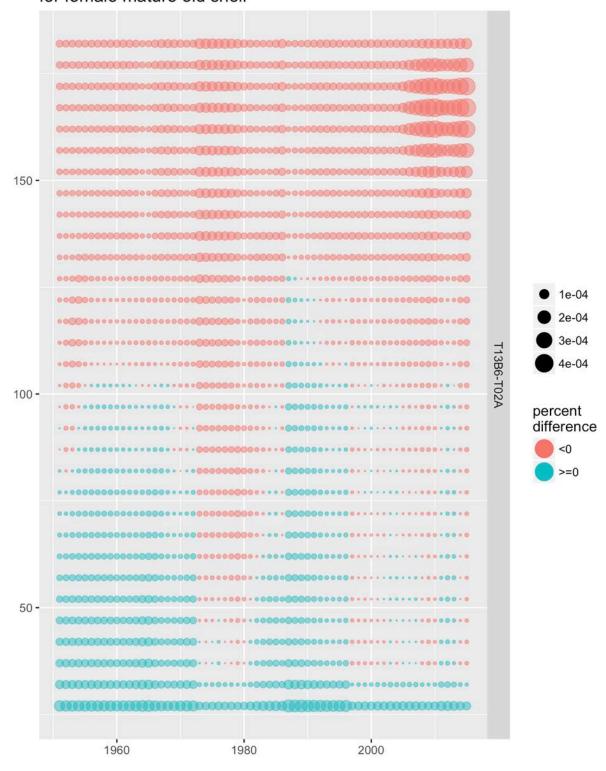


Figure 113. Differences for GTF fishery catch abundance for female mature old shell.

## GTF fishery catch abundance for male immature new shell

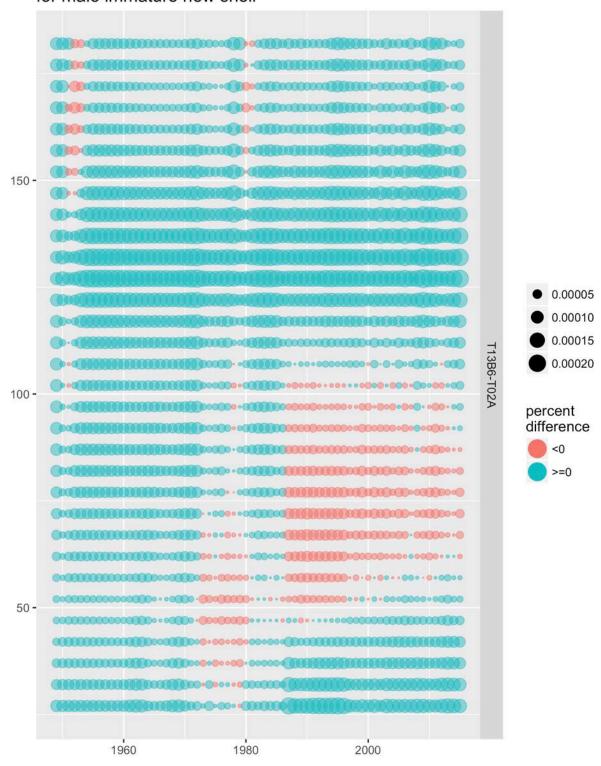


Figure 114. Differences for GTF fishery catch abundance for male immature new shell.

### GTF fishery catch abundance for male mature new shell

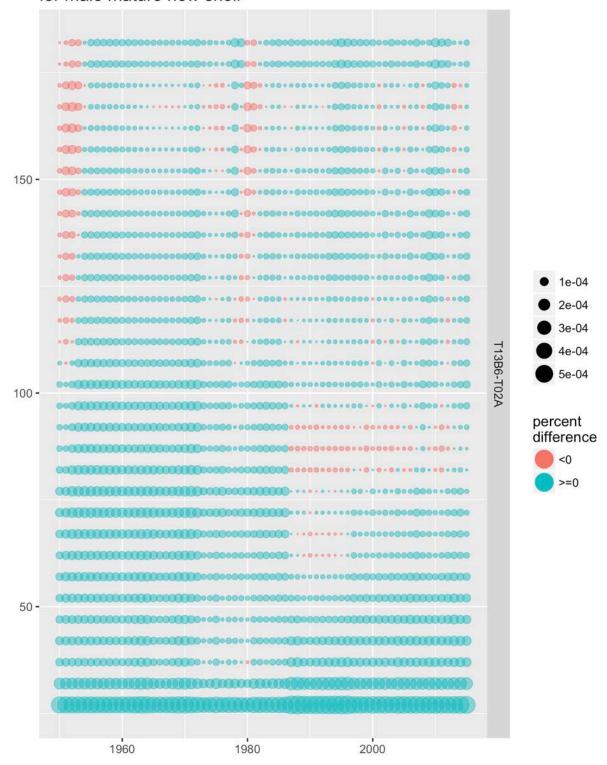


Figure 115. Differences for GTF fishery catch abundance for male mature new shell.

#### GTF fishery catch abundance for male mature old shell

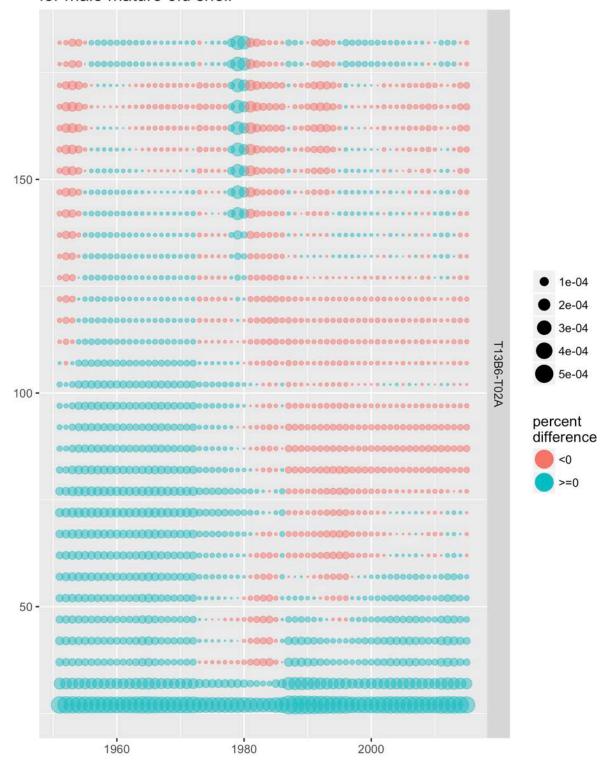


Figure 116. Differences for GTF fishery catch abundance for male mature old shell.

## GTF fishery catch abundance for female immature new shell

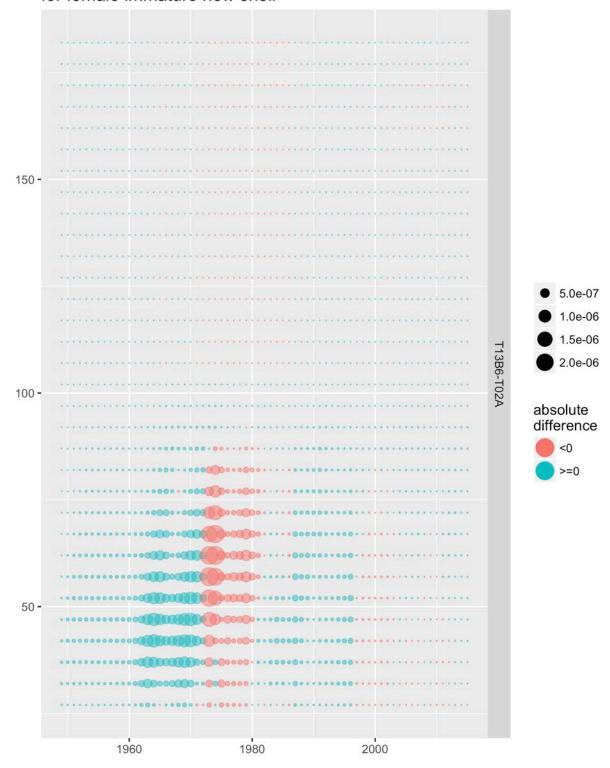


Figure 117. Differences for GTF fishery catch abundance for female immature new shell.

## GTF fishery catch abundance for female mature new shell

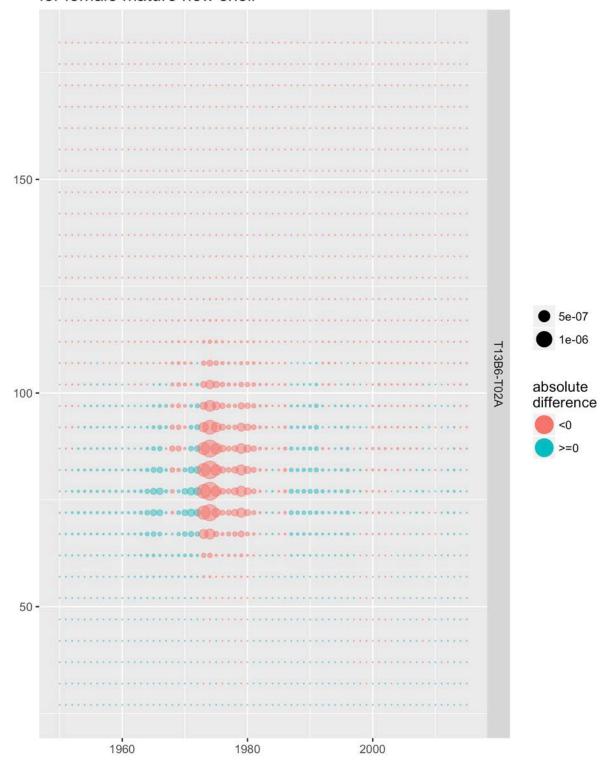


Figure 118. Differences for GTF fishery catch abundance for female mature new shell.

## GTF fishery catch abundance for female mature old shell

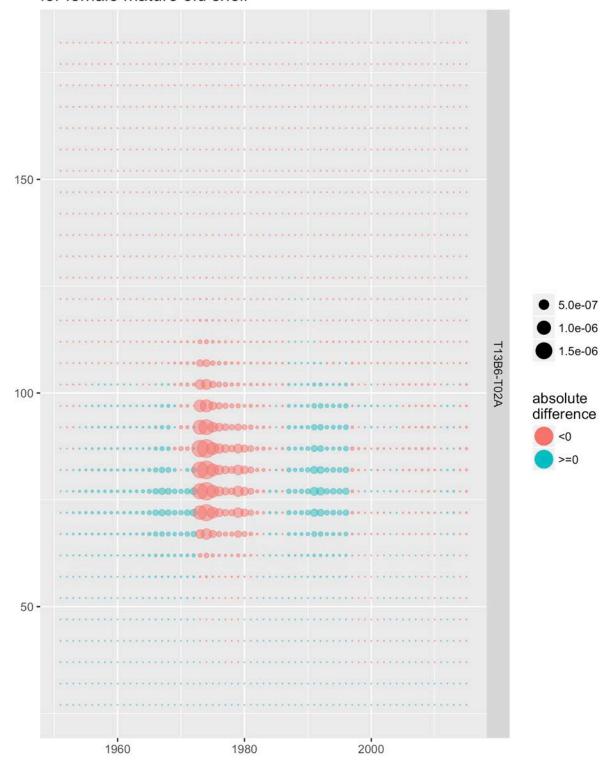


Figure 119. Differences for GTF fishery catch abundance for female mature old shell.

### GTF fishery catch abundance for male immature new shell

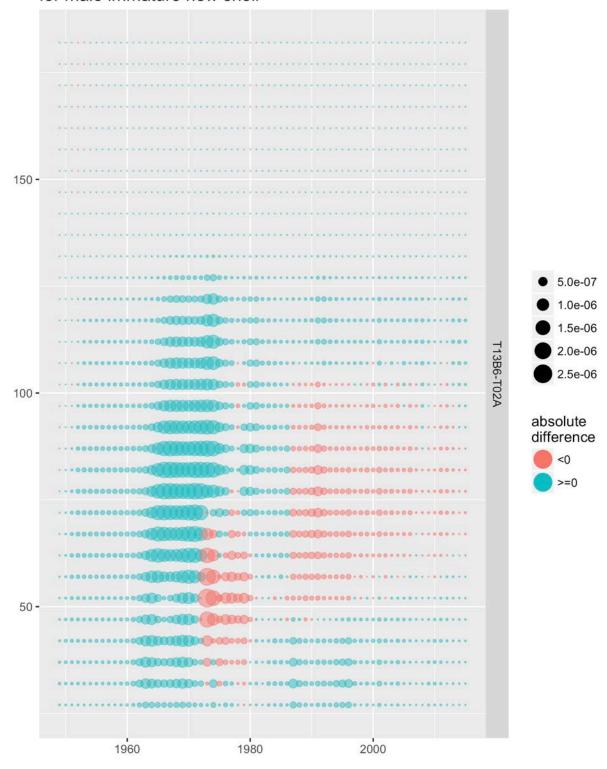


Figure 120. Differences for GTF fishery catch abundance for male immature new shell.

### GTF fishery catch abundance for male mature new shell

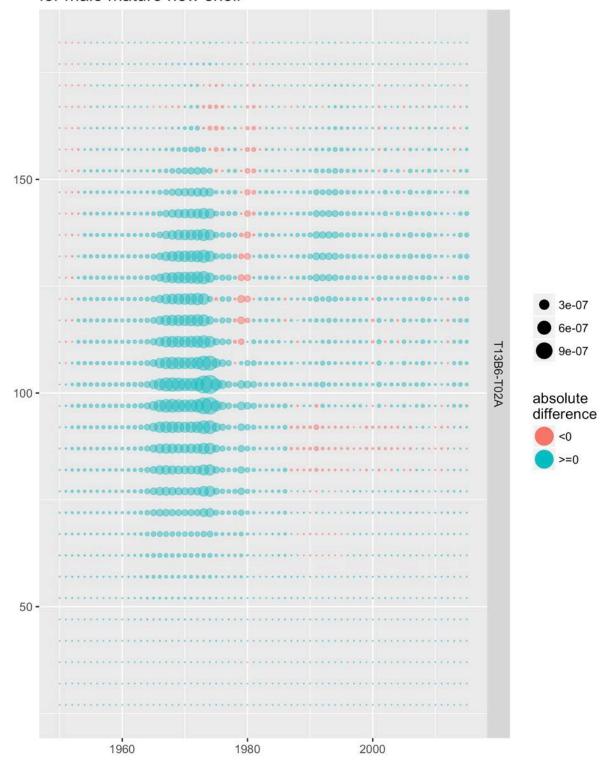


Figure 121. Differences for GTF fishery catch abundance for male mature new shell.

## GTF fishery catch abundance for male mature old shell

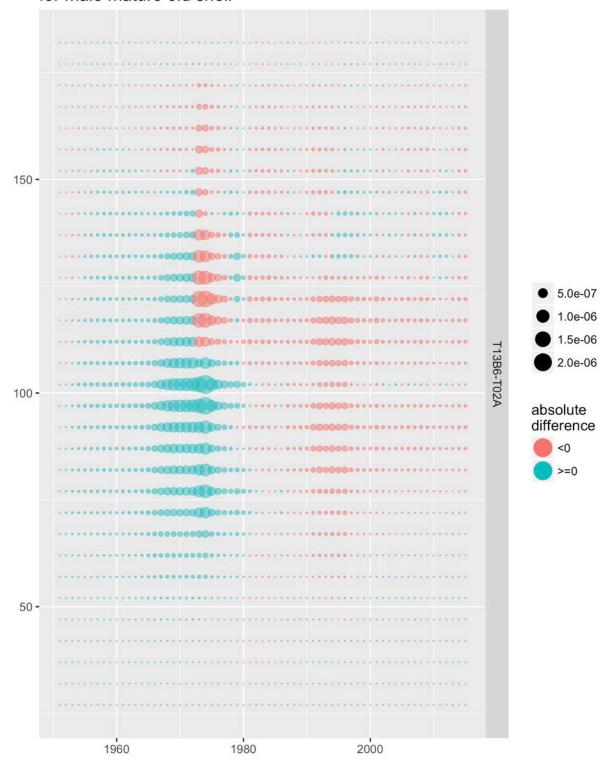


Figure 122. Differences for GTF fishery catch abundance for male mature old shell.

# RKF fishery catch abundance for female immature new shell

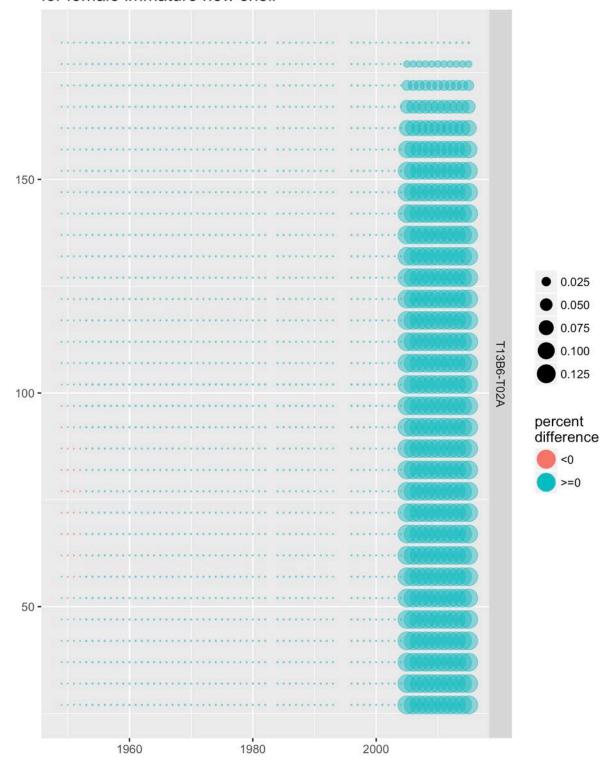


Figure 123. Differences for RKF fishery catch abundance for female immature new shell.

## RKF fishery catch abundance for female mature new shell

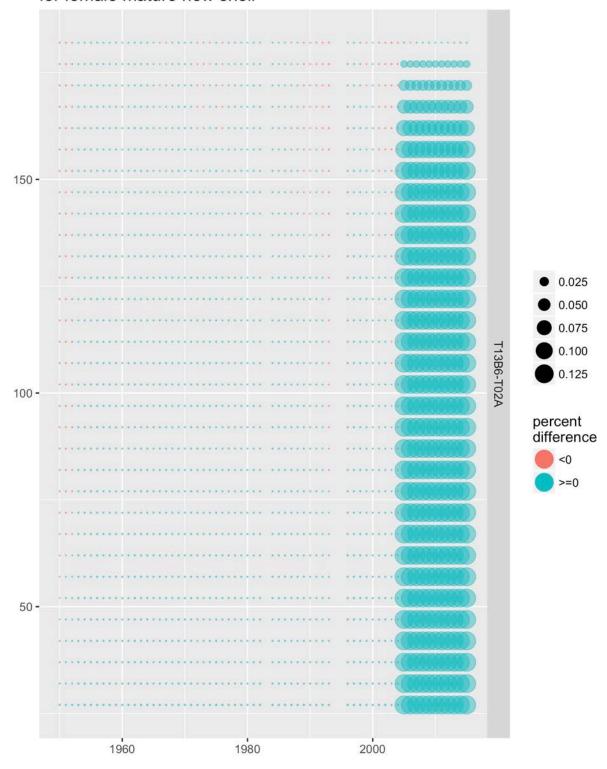


Figure 124. Differences for RKF fishery catch abundance for female mature new shell.

# RKF fishery catch abundance for female mature old shell

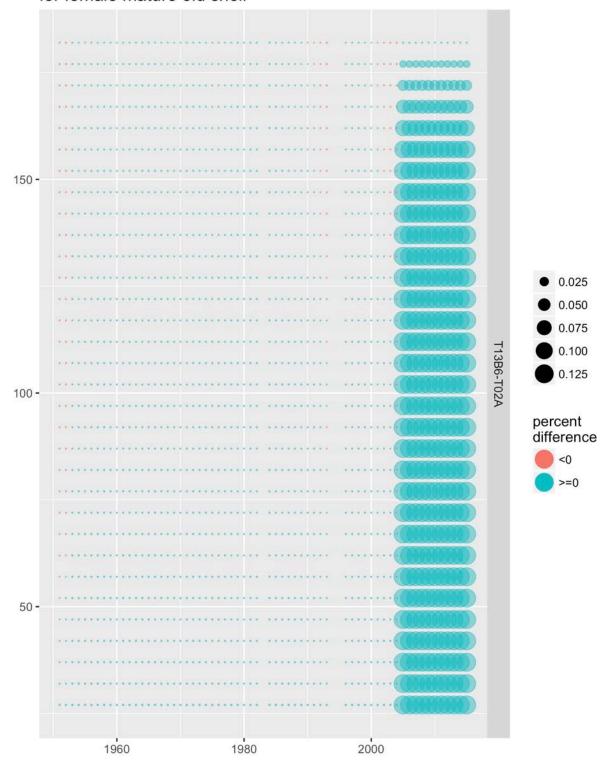


Figure 125. Differences for RKF fishery catch abundance for female mature old shell.

### RKF fishery catch abundance for male immature new shell

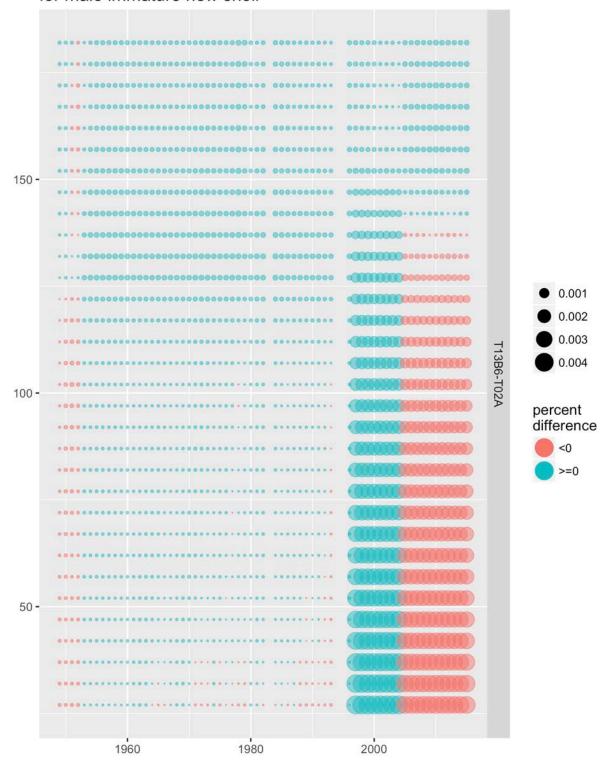


Figure 126. Differences for RKF fishery catch abundance for male immature new shell.

### RKF fishery catch abundance for male mature new shell

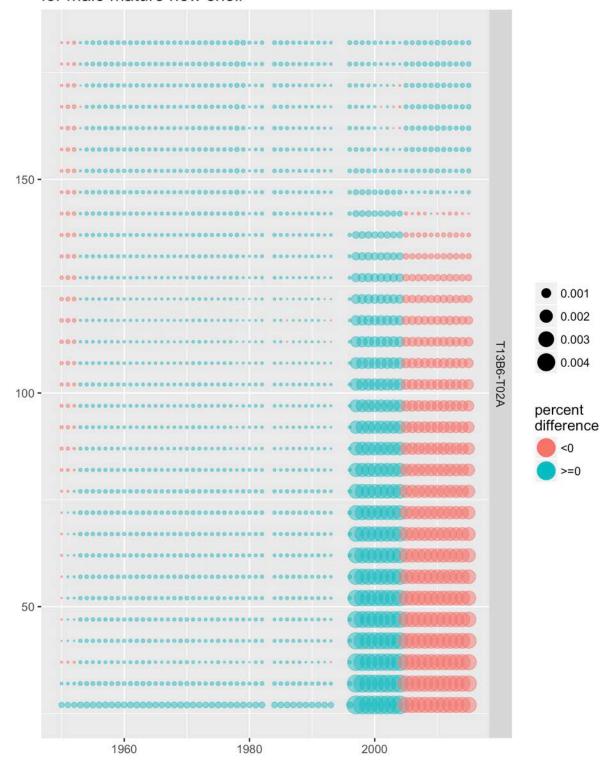


Figure 127. Differences for RKF fishery catch abundance for male mature new shell.

### RKF fishery catch abundance for male mature old shell

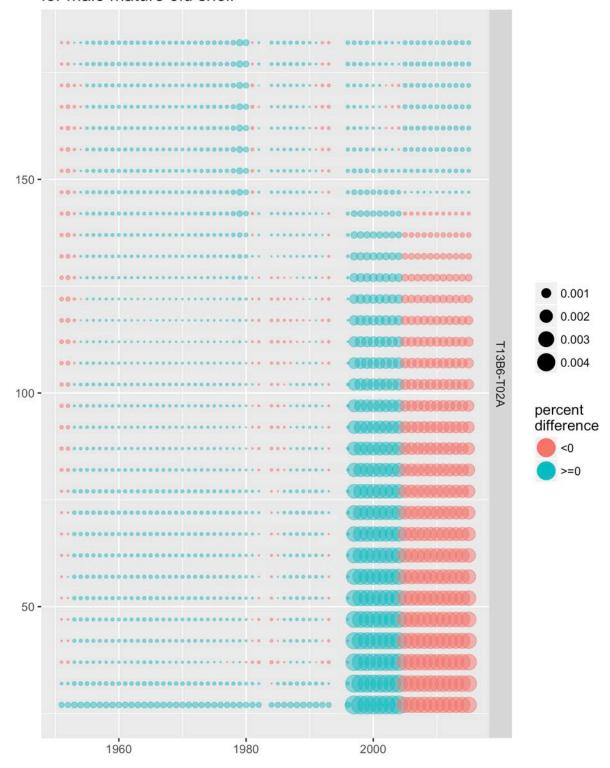


Figure 128. Differences for RKF fishery catch abundance for male mature old shell.

## RKF fishery catch abundance for female immature new shell

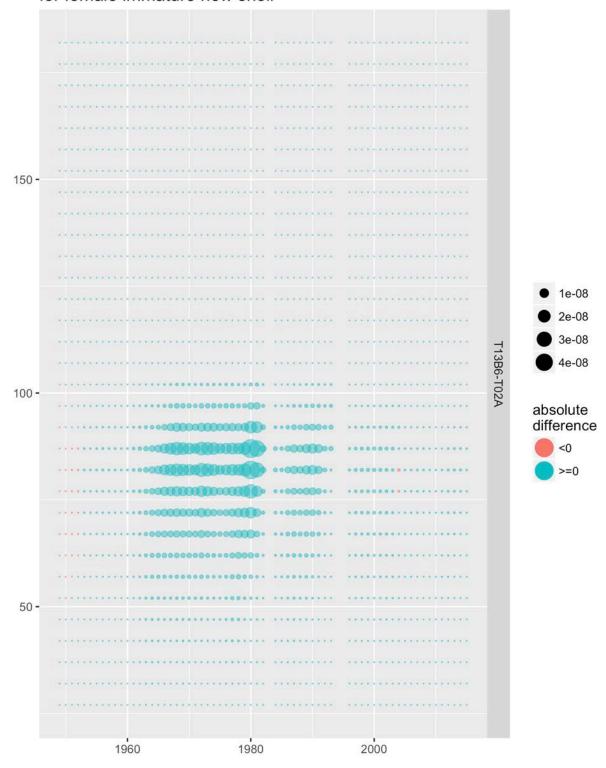


Figure 129. Differences for RKF fishery catch abundance for female immature new shell.

## RKF fishery catch abundance for female mature new shell

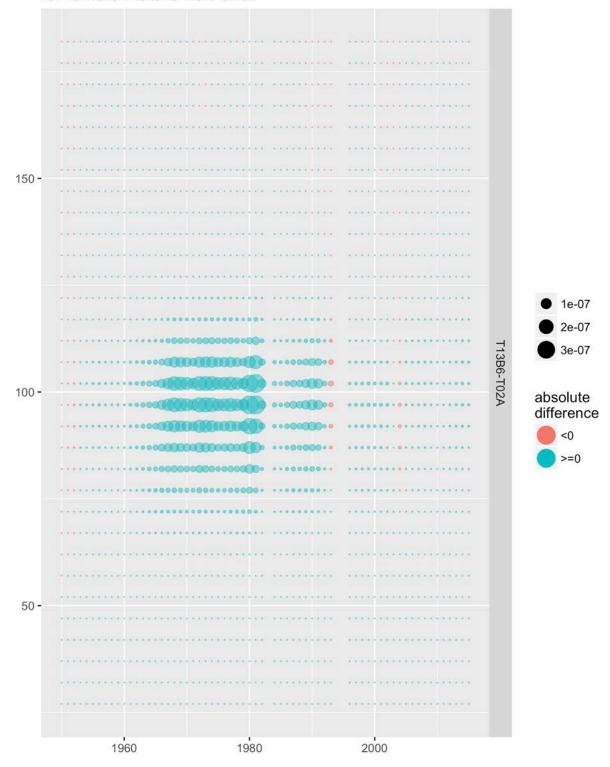


Figure 130. Differences for RKF fishery catch abundance for female mature new shell.

## RKF fishery catch abundance for female mature old shell

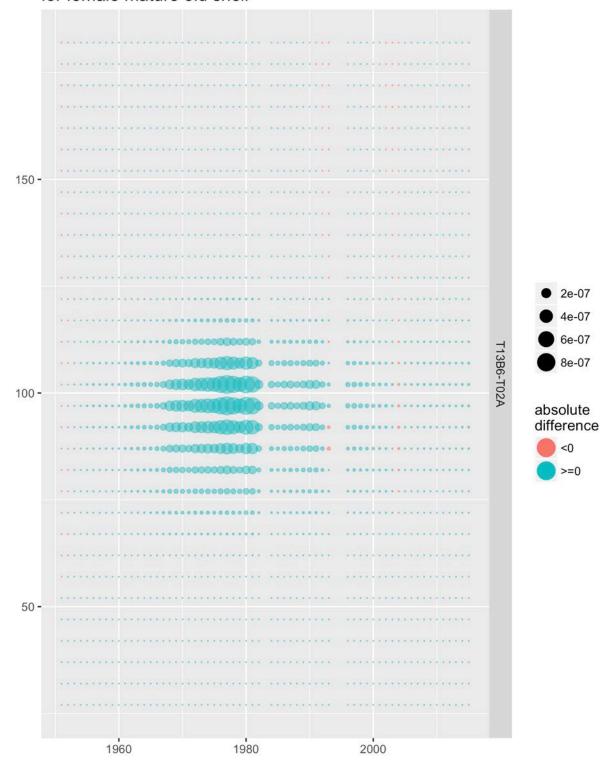


Figure 131. Differences for RKF fishery catch abundance for female mature old shell.

### RKF fishery catch abundance for male immature new shell

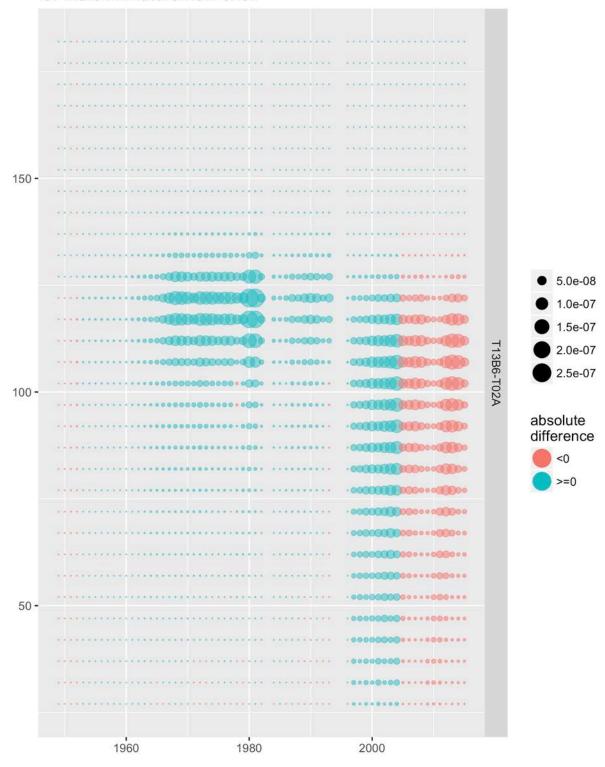


Figure 132. Differences for RKF fishery catch abundance for male immature new shell.

# RKF fishery catch abundance for male mature new shell

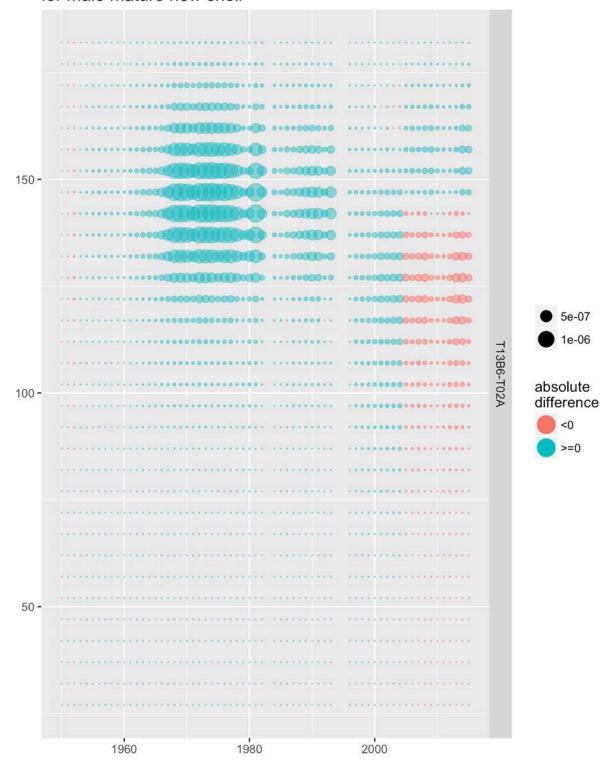


Figure 133. Differences for RKF fishery catch abundance for male mature new shell.

## RKF fishery catch abundance for male mature old shell

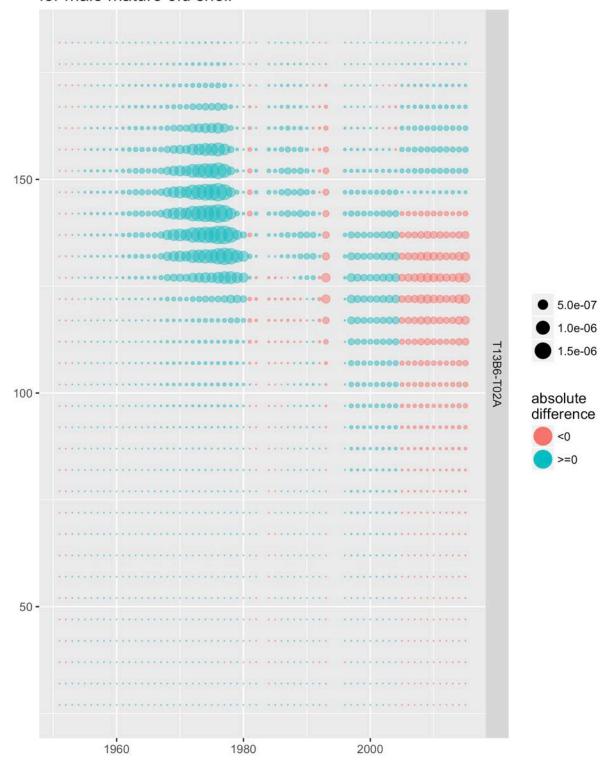


Figure 134. Differences for RKF fishery catch abundance for male mature old shell.

#### **Total catch biomass**

#### TCF: fishery total biomass

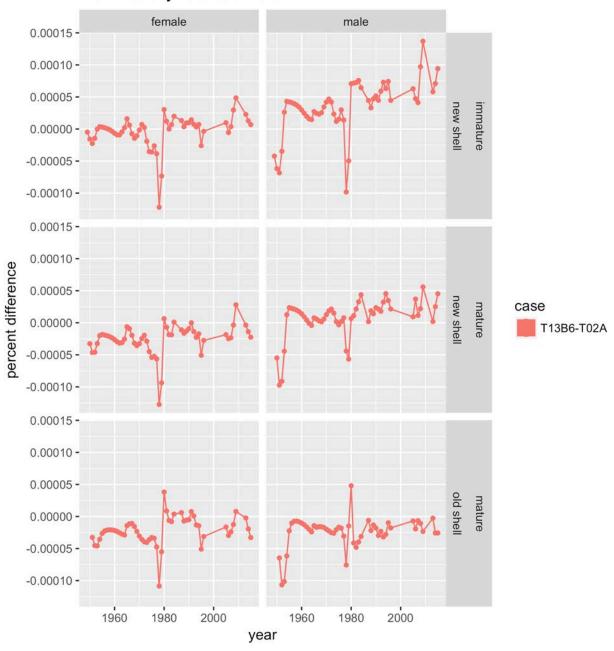


Figure 135. Differences for TCF: fishery total biomass.

### TCF: fishery total biomass female male 0.00000 --0.00005 new shell immature -0.00010 --0.00015 -0.00000 absolute difference -0.00005 new shell case T13B6-T02A -0.00010 --0.00015 -0.00000 -

old shell

2000

1980

1960

year

Figure 136. Differences for TCF: fishery total biomass.

1980

1960

2000

-0.00005 -

-0.00010 -

-0.00015 -

### SCF: fishery total biomass

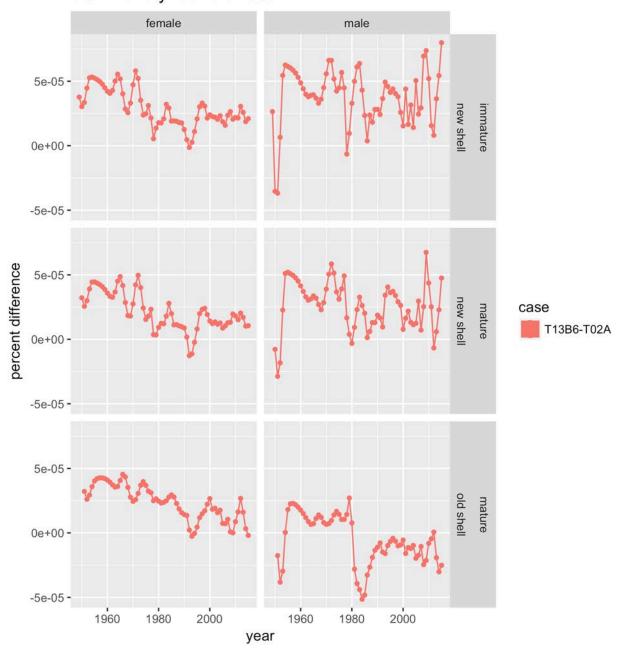


Figure 137. Differences for SCF: fishery total biomass.

### SCF: fishery total biomass

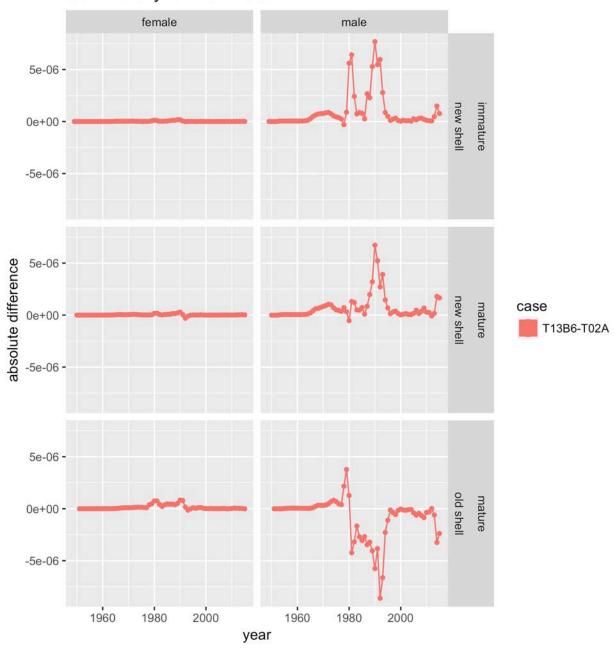


Figure 138. Differences for SCF: fishery total biomass.

### GTF: fishery total biomass

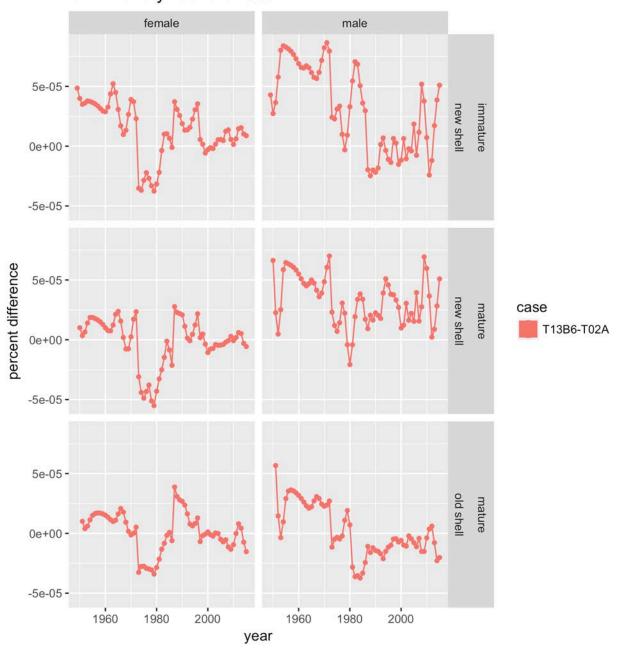


Figure 139. Differences for GTF: fishery total biomass.

### GTF: fishery total biomass

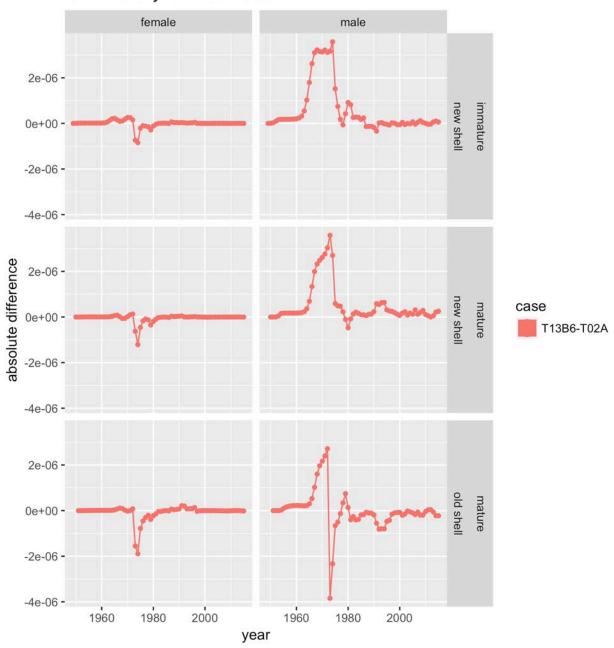


Figure 140. Differences for GTF: fishery total biomass.

### RKF: fishery total biomass

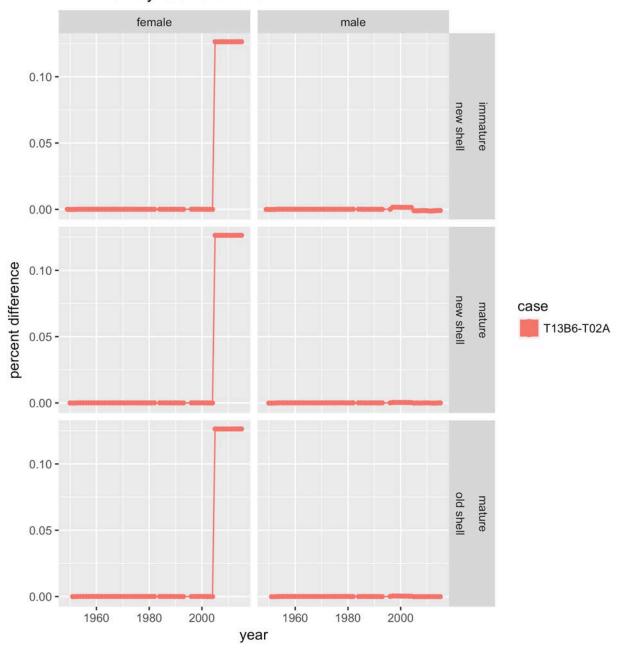


Figure 141. Differences for RKF: fishery total biomass.

### RKF: fishery total biomass

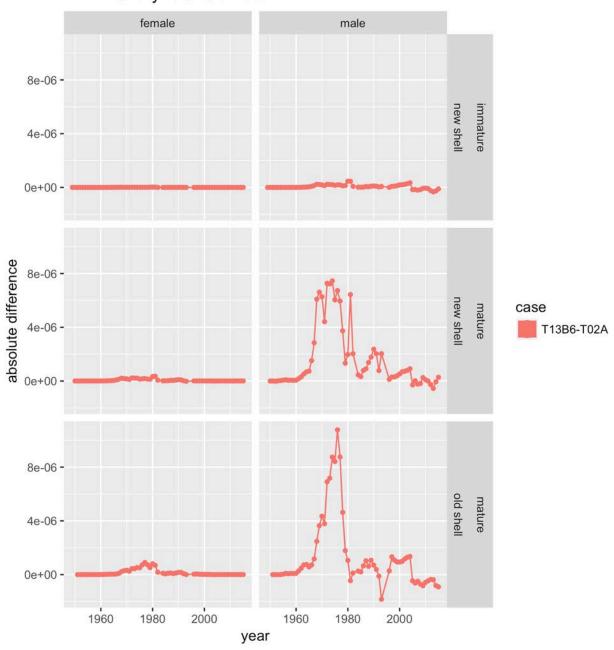


Figure 142. Differences for RKF: fishery total biomass.

#### **Retained catch abundance**

#### TCF: retained catch abundance

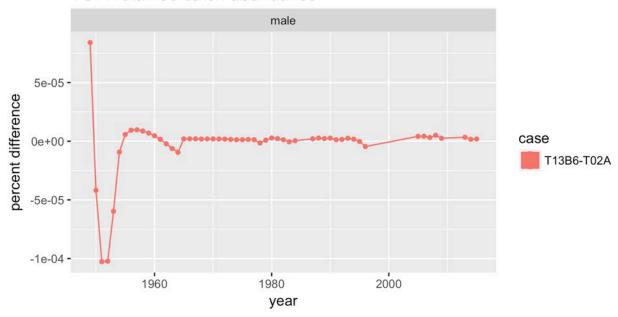


Figure 143. Differences for TCF: retained catch abundance.

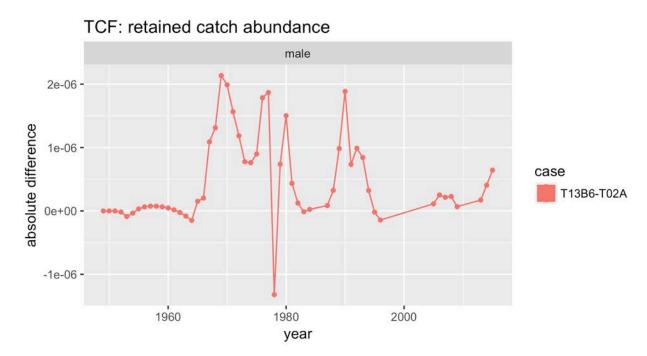


Figure 144. Differences for TCF: retained catch abundance.

# TCF retained catch abundance for male all maturity all shell

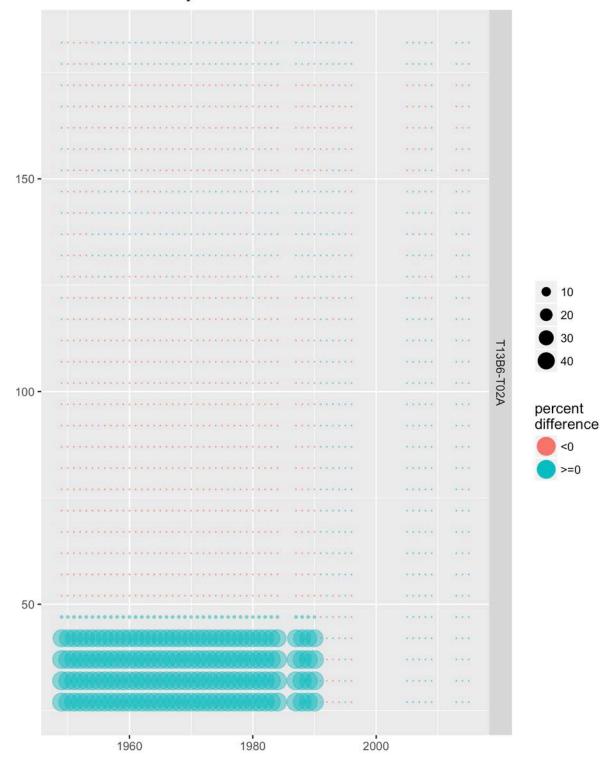


Figure 145. Differences for TCF retained catch abundance for male all maturity all shell.

### TCF retained catch abundance for male all maturity all shell

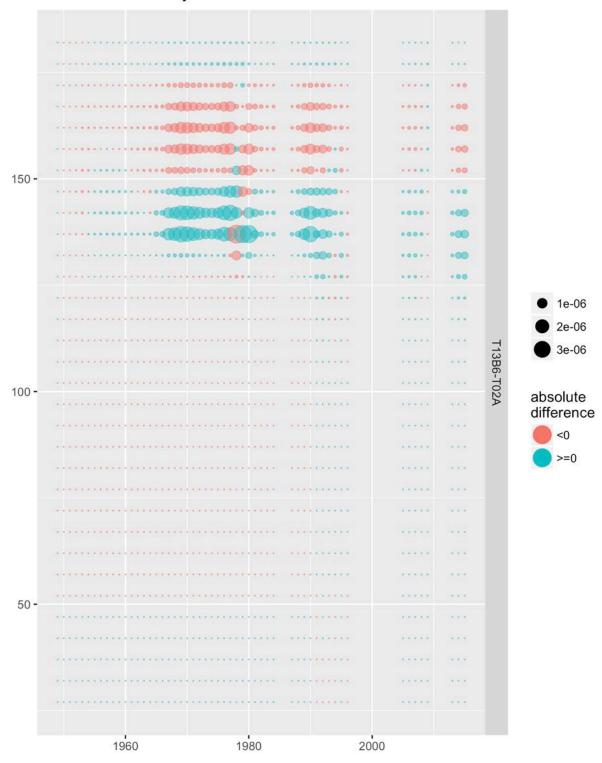


Figure 146. Differences for TCF retained catch abundance for male all maturity all shell.

#### **Retained catch biomass**

#### TCF: retained catch biomass

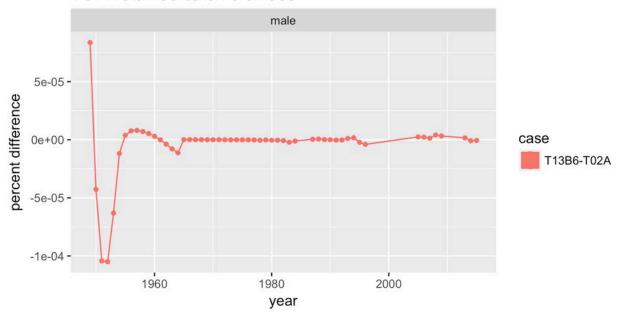
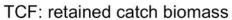


Figure 147. Differences for TCF: retained catch biomass.



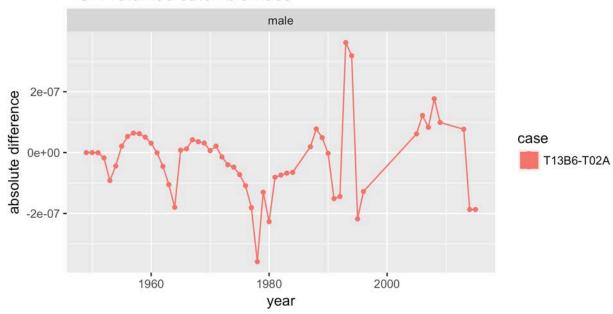


Figure 148. Differences for TCF: retained catch biomass.