# A new OMP for West Coast rock lobster: preliminary results

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OMP-2007 re-cast which has been used to set the TAC for the west coast rock lobster resource for the previous four years is now due to be updated. This OMP was based on recent trends in Trap, Hoop and FIMS indices, as well as somatic growth rate trends. It also included fitting a simple population model to these data and using output from that model as input into the OMP.

It is suggested that the new 2011 OMP be simplified and be empirically based only – i.e. the simple population model fitting part of the OMP would fall away. The aim is to achieve simplicity in the OMP approach to enable easier understanding of how it works. The suggested new approach is based on the approach currently used for South African Hake OMP.

This new OMP 2011 sets a TAC in relation to the relative level of recent CPUE (trap and hoop) and FIMS survey abundance indices compared to a target level. It also adjusts the TAC according to recent levels of somatic growth.

The methods used for combining the data across the five super-areas to produce a single index for the resource remains the same as for OMP 2007 re-cast. See Johnston and Butterworth (2010) for details.

## Method for calculating the Global TAC

$$TAC_y^G = \alpha\left(\bar{J}_y - J_{min}\right) \quad (1)$$

where

α and $J_{min}$ are two tuning parameters, and

$\bar{J}_y$ is the combined abundance index – combined over both super-areas and gear-type.

$$\bar{J}_y = \sum_{gear=1}^{3} W^{gear} J_y^{gear} \qquad (2)$$

where

$J_y^{gear}$ is a relative measure of the immediate past level in the abundance index "gear" (trap, hoop or FIMS) as available for use in calculation of the global TAC for year *y*

$$J_y^{gear} = [\frac{1}{3}\sum_{y'=y-3}^{y-1} J_{y'}^{gear}] / \frac{1}{5}\sum_{y'=2005}^{2009} J_{y'}^{gear} \qquad (3)$$

and

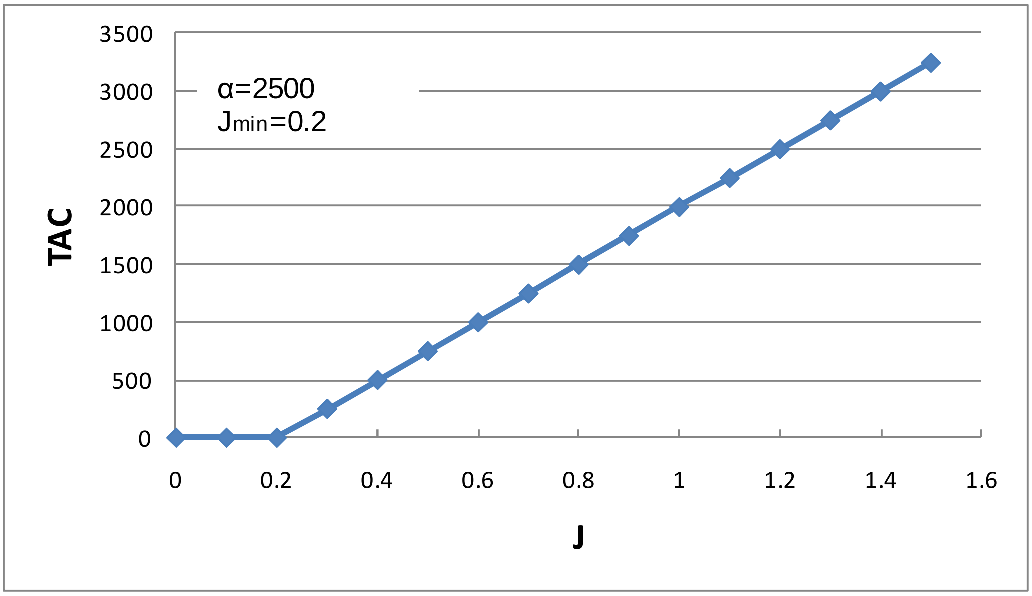
$W^{gear}$ is the relative weight given to that gear type.

The $W^{gear}$ values were calculated in relation to the variances associated with the operating model fits to the associated indices of abundance (see Appendix 1 for details). The values used are:

$W^{trap} = 1$ ; $W^{hoop} = 1$; and $W^{FIMS} = 0.25$, which when renormalised to sum to 1.0 are:

$W^{trap} = 0.44$ ; $W^{hoop} = 0.44$; and $W^{FIMS} = 0.12$.

Figure 1: The illustrative figure below shows the TAC as a function of "J".



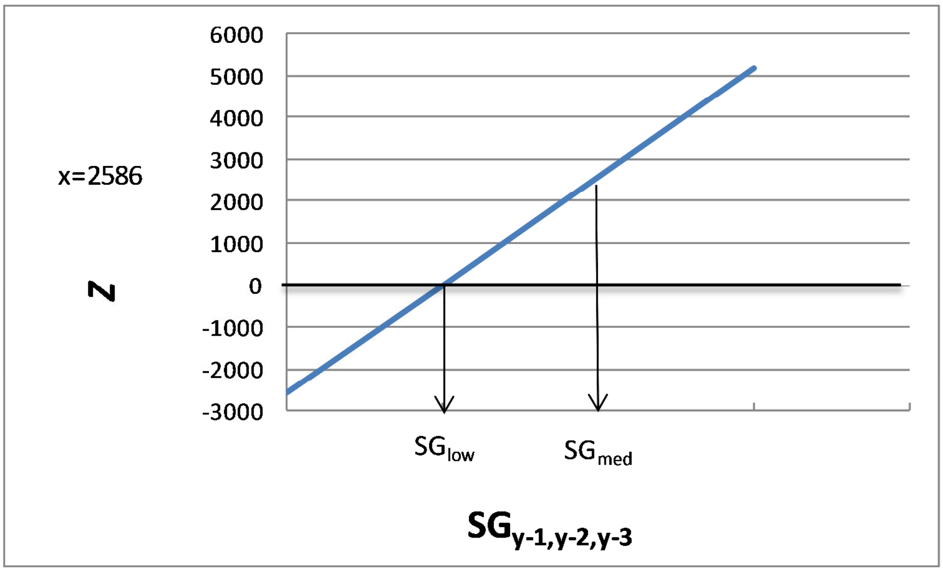
*Adjusting TAC for recent somatic growth*

The global TAC value is then adjusted up or down by the addition or subtraction of an amount "Z" such that:

and where

where is the geometric mean of the combined somatic growth index for the three most recent seasons. The value of , which is 2586 MT, was calculated by comparing the tonnage differentials between the low and medium somatic growth rates that would result in the same biomass level after 10 years. See Appendix 2 for details. Figure 2 below illustrates the dependence of *Z* on .

Figure 2: The relationship between *Z* and (see Equation 5).




If is equal to $SG_{low}$, then the value of *Z* will be zero. If the value of is equal to $SG_{med}$, then the value of *Z* will be 2586 MT. If drops to below $SG_{low}$, then the value of *Z* will be negative, and the TAC will be adjusted downwards.

## Method for calculating the sector splits: two alternate approaches

Table 1a: Sector splits of global TAC (“Current”)

| Sector | Baseline % of Global TAC | Range of global TAC allowed before revert to baseline | Maximum allowed |
|---|---|---|---|
| Recreational | 5% | 3% - 6% | 250 MT |
| Subsistence/IR | 8.8% | 7% - 11% | 500 MT |
| Nearshore commercial | 19.7% | 16% - 24% | 800 MT |
| Offshore commercial | 66.5% | Currently max 10% pa | - |

Table 1b: Sector splits of global TAC (“Alternative suggested”)

| Sector | Baseline % of Global TAC | Range of global TAC allowed before revert to baseline | Maximum allowed | 2011 starting value |
|---|---|---|---|---|
| Recreational | 8% | 6% - 10% | 400 MT | 182.9 MT |
| Subsistence/IR | 11% | 8% - 14% | 600 MT | 251.48 MT |
| Nearshore commercial | 19.7% | 16% - 24% | 800 MT | 451 MT |
| Offshore commercial | 61.3% | Currently max 10% pa | - | No less than 90% of 2010 value |

## Method for splitting the sector TACs between super-area

Table 1c: Super-area splits of the different sector TACs/allocations

| | **Offshore*** | **Nearshore** | **Subsistence** | **Recreational** |
|---|---|---|---|---|
| **A1+2** | 0 | 0.0536 | 0.033 | 0.02 |
| **A3+4** | 0.034 | 0.1607 | 0.207 | 0.125 |
| **A5+6** | 0 | 0.0714 | 0.246 | 0.125 |
| **A7** | 0.251 | 0.000 | 0.000 | 0.04 |
| **A8+** | 0.715 | 0.7143 | 0.513 | 0.69 |

*These values are taken to be the same proportions allocated for the 2010 season

## Simulation Method

A slightly different simulation method has been used. For each simulation a set of random numbers is generated which are used to select between the various choices that are required for future somatic growth (2 options), future recruitment (3 options), current abundance levels (3 options), historic poaching level (2 options) and future poaching levels (6 options). The weights that each of these options receive remain the same as defined previously.

Results reported here are for 50 simulations. The medians and 5$^{th}$ and 95$^{th}$ percentiles are calculated from these 50 simulations. At a later stage, the number of simulations will be increased, but for initial OMP development, 50 simulations are considered to be sufficient.

## Results

Results for the OMP described above have been produced for a range of α and $J_{min}$ values. These results have been produced for the "newly suggested sector split". A summary of the median and lower 5$^{th}$ percentile of the B75m(2021/2006) values along with the associated Global TAC for the full range of α and $J_{min}$ explored here are presented in Tables 2a and b.

Detailed results for α=2250 and $J_{min}$=0.2 are reported in Table 3, and Figures 3a and b..

Comparative results for the "current sector split" option for values of α =2250 and $J_{min}$=0.2 are also reported in Table 3, and Figures 4a and b.

*What if future recruitment is low?*

The same set of 50 simulations were run (for the "alternative suggested sector split" and values of α =2250 and $J_{min}$=0.2) but for all simulations the future recruitment was set to the "low" level. These results are also presented in Table 3.

## Discussion points

1) Downward trend of B75m for super-area A8+ of the lower 5$^{th}$ percentile in super-areas A7 and A8 in particular

2) High risk of heavy depletion in super-areas A7 and A8 under low recruitment scenarios in need for an option to override maximum TAC reduction given evidence in Table 3 of weak feedback control correction to TAC.

## Decisions to be made by SWG

1) Relative weighting of indices – confimation of the proposals in Appendix 1
2) Global and super-area B75m(2021/2006) tuning values to be considered – medians and lower $5^{th}$ (or other) percentiles
3) Rules for improving performance in certain super-areas by transfer of offshore commercial allocation amongst super-areas.

## Reference

Johnston, S.J. and D.S. Butterworth. 2010. OMP 2007 re-cast to be used for setting TACs for the west coast rock lobster fishery for the 2008+ seasons. Fisheries/2010/Aug/SWG-WCRL/13.

Table 2a: Bexp(2021)/(2006) median values and lower 5th percentiles (in parentheses) for a range of α and $J_{min}$ values. Results are for the “alternative sector splits”.

| | $J_{min}$ | | | | |
|---|---|---|---|---|---|
| α | **0.05** | **0.1** | **0.2** | **0.3** | **0.4** |
| **2000** | 1.23 (0.72) | 1.25 (0.73) | 1.31 (0.77) | 1.37 (0.83) | 1.38 (0.87) |
| **2250** | 1.12 (0.63) | 1.17 (0.66) | 1.25 (0.72) | 1.31 (0.77) | 1.37 (0.84) |
| **2500** | 1.06 (0.60) | 1.09 (0.62) | 1.17 (0.66) | 1.25 (0.70) | 1.32 (0.79) |

Table 2b: Global TAC median values for a range of α and $J_{min}$ values. Results are for the “alternative sector splits”.

| | $J_{min}$ | | | | |
|---|---|---|---|---|---|
| α | **0.05** | **0.1** | **0.2** | **0.3** | **0.4** |
| **2000** | 2224 | 2179 | 2045 | 1948 | 1848 |
| **2250** | 2378 | 2319 | 2188 | 2045 | 1927 |
| **2500** | 2618 | 2517 | 2323 | 2170 | 2021 |

Table 3: Comparison between three initial 2011 OMPs. Medians with 5th and 95th percentile values shown in parentheses.

| | | **Normal simulation method** | **All future Recruitment=low** | **Normal simulation method** |
|---|---|---|---|---|
| | Sector split method | **Alternative suggested method** | **Alternative suggested method** | **Current method** |
| | α | **2250** | **2250** | **2250** |
| | $J_{min}$ | **0.2** | **0.2** | **0.2** |
| **10-yr (2011-2020) Ave Global TAC** | A1-2 | 34 (30; 41) | 34 (29; 41) | 32 (26; 36) |
| | A3-4 | 187 (158; 223) | 183 (152; 223) | 184 (150; 208) |
| | A5-6 | 114 (95; 131) | 112 (94; 131) | 91 (77; 103) |
| | A7 | 343 (279; 434) | 331 (258; 428) | 409 (331; 484) |
| | A8 | 1509 (1256; 1863) | 1473 (1180; 1841) | 1467 (1184; 1699) |
| | T | 2189 (1921; 2693) | 2134 (1713; 2667) | 2186 (1765; 2529) |
| **10-yr (2011-2020) Ave offshore TAC** | A1-2 | 0 (0; 0) | 0 (0; 0) | 0 (0; 0) |
| | A3-4 | 45 (37; 58) | 44 (34; 57) | 60 (48; 70) |
| | A5-6 | 0 (0; 0) | 0 (0; 0) | 0 (0; 0) |
| | A7 | 335 (273; 426) | 324 (252; 421) | 405 (327; 480) |
| | A8 | 954 (776; 1213) | 922 (718; 1196) | 983 (793;1164) |
| | T | 1335 (1086; 1697) | 1290 (1005; 1674) | 1448 (1168; 1715) |
| **10-yr (2011-2020) Ave near shore TAC** | A1-2 | 23 (20; 27) | 22 (19; 27) | 23 (19; 26) |
| | A3-4 | 67 (59; 82) | 67 (56; 82) | 69 (58; 79) |
| | A5-6 | 30 (26; 37) | 30 (25; 37) | 30 (26; 35) |
| | A7 | 0 (0; 0) | 0 (0; 0) | 0 (0; 0) |
| | A8 | 301 (264; 366) | 296 (250; 366) | 306 (257; 349) |
| | T | 421 (370; 512) | 414 (350; 512) | 428 (360; 489) |
| **10-yr (2011-2020) Ave subsistence TAC** | A1-2 | 8 (7; 9) | 8 (7; 9) | 6 (5; 7) |
| | A3-4 | 51 (42; 58) | 51 (42; 58) | 40 (34; 46) |
| | A5-6 | 61 (50; 69) | 60 (50; 69) | 47 (40; 55) |
| | A7 | 0 (0; 0) | 0 (0; 0) | 0 (0; 0) |
| | A8 | 126 (104; 145) | 126 (105; 144) | 99 (84; 115) |
| | T | 246 (204; 280) | 245 (204; 280) | 193 (163; 224) |
| **10 yr (2011-2020) Ave Total Recreational Take** | T | 183 (148; 204) | 179 (148; 203) | 106 (86; 107) |
| **$B75_m$(21/06)** | A1-2 | 1.30 (0.61; 2.65) | 0.96 (0.51; 1.70) | 1.37 (0.67; 2.69) |
| | A3-4 | 1.55 (0.94; 2.58) | 0.96 (0.75; 1.86) | 1.56 (0.94; 2.60) |
| | A5-6 | 1.74 (1.38; 3.48) | 1.42 (1.21; 1.84) | 1.82 (1.44; 3.52) |
| | A7 | 2.21 (0.28; 8.90) | 0.09 (0.003; 0.94) | 1.98 (0.16; 8.76) |
| | A8 | 0.54 (0.13; 1.39) | 0.10 (0.00; 0.52) | 0.61 (0.20; 1.44) |
| | **T** | **1.25 (0.72; 2.80)** | **0.58 (0.41; 0.83)** | **1.26 (0.75; 2.81)** |

Figure 3a: Total Global TAC and B75m trajectories for the "alternative suggested sector split" option for the case $J_{min}$=0.2 and α=2250. Medians and 5$^{th}$ and 95$^{th}$ percentiles shown. Global recreational allocations are also reported.

Figure 3b: Offshore, nearshore and subsistence allocation trajectories for the "alternative suggested sector split" for the case $J_{min}$=0.2 and α=2250. Medians and 5th and 95th percentiles shown.

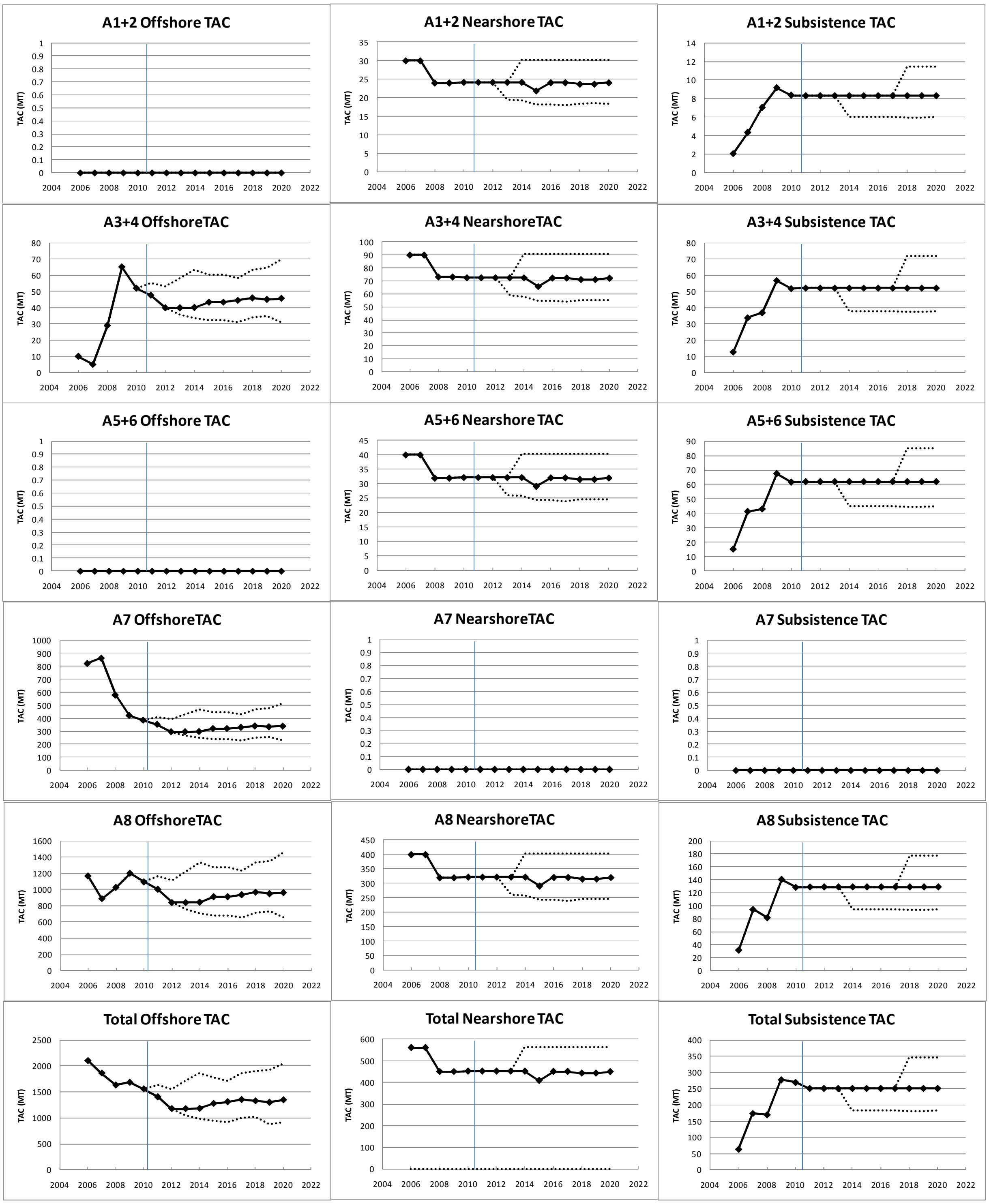


Figure 4a: Total Global TAC and B75m trajectories for the “current sector split” option for the case $J_{min}$=0.2 and α=2250. Medians and $5^{th}$ and $95^{th}$ percentiles shown.

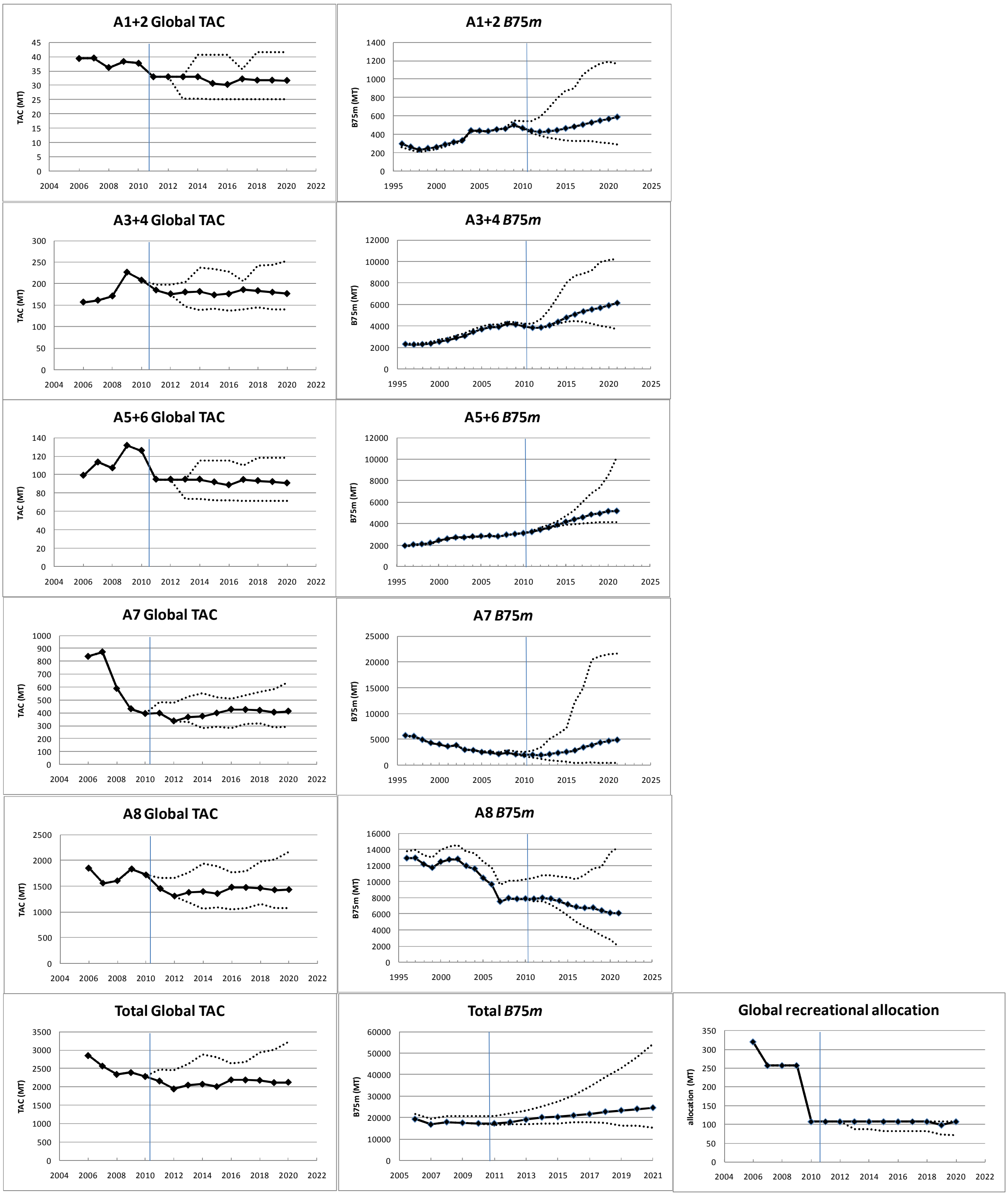
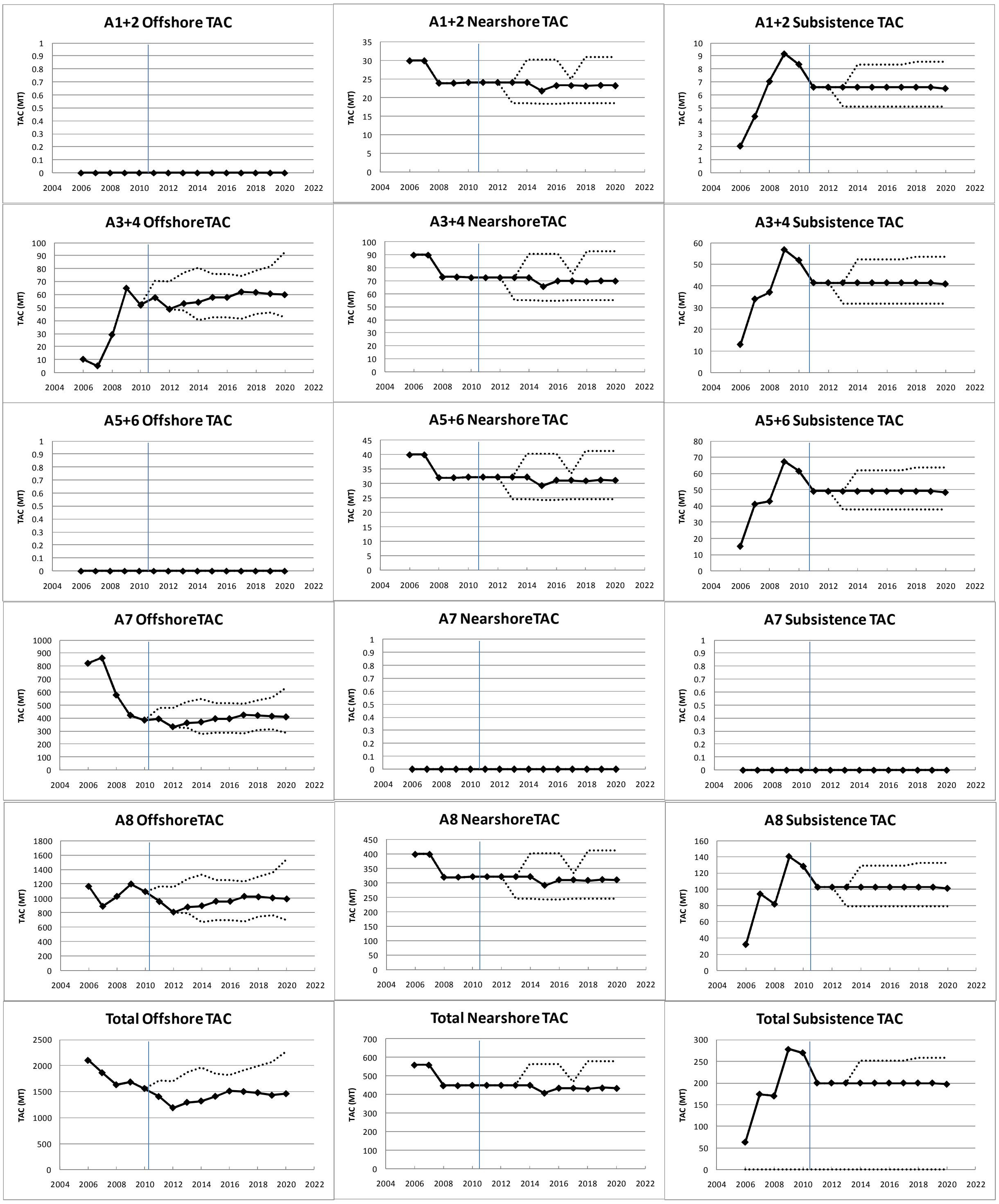


Figure 4b: Offshore, nearshore and subsistence allocation trajectories for the "current sector split" for the case $J_{min}$=0.2 and α=2250. Medians and 5$^{th}$ and 95$^{th}$ percentiles shown. Global recreational allocations are also reported.



**Appendix 1: Calculation of the $W^{gear}$ values**

Table A1: The σ values obtained form the model fits to data for each gear type and super-area.

| Gear type | Area 1+2 | Area 3+4 | Area 5+6 | Area 7 | Area 8 |
|---|---|---|---|---|---|
| Trap | - | - | - | 0.469 | 0.183 |
| Hoop | 0.202 | 0.491 | 0.424 | - | 0.175 |
| FIMS | - | 1.652 | 1.107 | 0.773 | 0.274 |

Table A1: The (rough) relative proportions of the σ values for each super super-area.

| Gear type | Area 1+2 | Area 3+4 | Area 5+6 | Area 7 | Area 8 |
|---|---|---|---|---|---|
| Trap | - | - | - | 1 | 1 |
| Hoop | 1 | 1 | 1 | - | 1 |
| FIMS | - | 3 | 3 | 1.5 | 1.5 |

On average this suggests relative σ values of:

Trap=1

Hoop=1

FIMS=2

Turning these into inverse variance weights one would get:

Trap=1 (1/(1*1))

Hoop=1 (1/(1*1))

FIMS=0.25 (1/(2*2))

**Appendix 2: Calculation of the $\bar{x}$ value in Equation 5.**

Projections for a 10 year period were computed assuming the future somatic growth rate for 2010+ was at the “low” 1989-2009 average level. Other assumptions - for example, future recruitment - were set equal to the option with the highest probability.

The resource was projected ahead under a global constant catch (CC) level of each of 1000 MT, 1500 MT, 2000 MT or 2500 MT. The exploitable (male) biomass level at the start of 2021 was recorded for each projection.

The resource was then projected ahead under the assumption that future somatic growth would be equal to the “medium” somatic growth level (the average of the 1968-2009 values). The CC levels were then calculated that would result in the same exploitable biomass levels as recorded for the equivalent “low” somatic growth projections. The differential between the two CC levels was recorded as “x”, and the average of the four x values results in $\bar{x}$.

| Low somatic growth | 1000 MT | 1500 MT | 2000 MT | 2500 MT |
|---|---|---|---|---|
| Medium, somatic growth | 3715 MT | 4108 MT | 4495 MT | 5027 MT |
| Bexp(2021) | 29903 MT | 25886 MT | 21730 MT | 17342 MT |
| $x$ | 2715 MT | 2608 MT | 2492 MT | 2527 MT |
| $\bar{x}$ | 2586 MT | | | |

The value of $SG_{low}$ in Equation 5 is 3.3596mm and the value of $SG_{med}$ is 4.2278mm.