Aquaculture Model

2018-11-27

Objective: Step through optimal harvest and planting decisions by a generic totoaba farm..

Toy Model:

Parameters for White seabass (Cynoscion nobiliis) from: Thomas, J. C. (1968). Management of the white seabass (Cynoscion nobilis) in California waters. State of California. The Resources Agency. Department of Fish and Game.

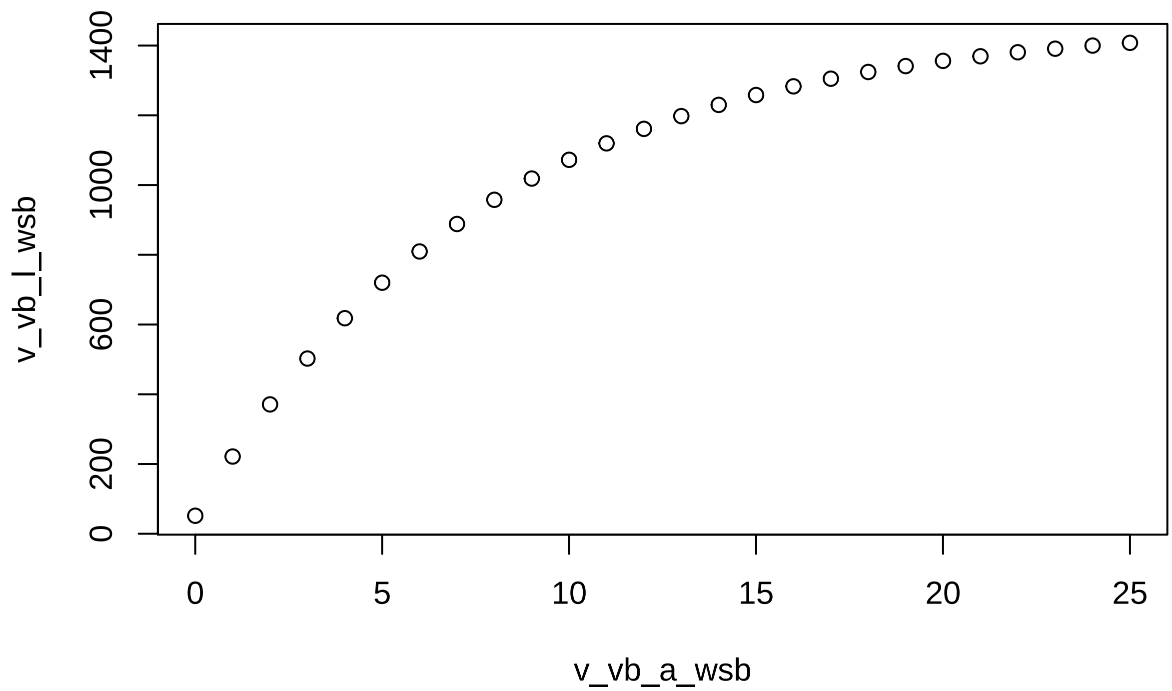
Von Bertalanffy Growth Model

$L(t) = L_\infty(1 - e^{-K(t-t_0)})$

Variable	Definition
L	Length (Millimeters)
L_∞	Maximum Length (mm)
K	Catabolic Constant (?!)
t	Age (Years)
t_0	Age, $L = 0$

```
# Von Bertalanffy function.
fn_vb = function(linf, k, t, t_0){l = linf * ( 1 - exp( - k * ( t - t_0)))}

# White seabass demo with age in years and length in millimeters.
v_vb_a_wsb = seq(0, 25)
v_vb_l_wsb = fn_vb(1465.3822, 0.1280, v_vb_a_wsb, -0.2805)
plot(v_vb_a_wsb, v_vb_l_wsb)
```




```
# Totoaba demo.
#v_vb_a_tma = seq(a0, amax)
#v_vb_l_tma = fn_vb(linf, k, v_vb_a_tma, t_0)
#plot(v_vb_a_tma, v_vb_l_tma)
```

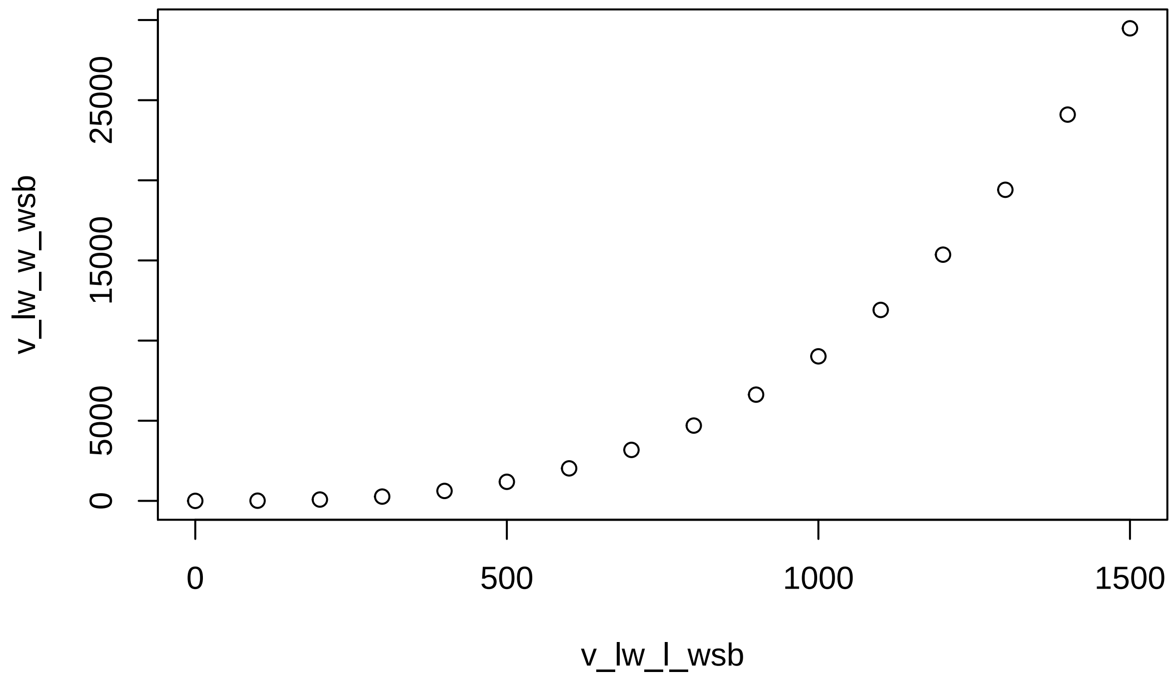
Weight-Length Conversion

$W = aL^b$

Variable	Definition
W	Weight (Grams)
a	Length (Millimeters)
L	Parameter
b	Parameter

```
# Generic length-to-weight conversion.
fn_lw = function(a, l, b){ w = a * l ^ b }

# White seabass demo in mm:g.
v_lw_l_wsb = seq(0, 1500, by = 100)
v_lw_w_wsb = fn_lw(0.000015491, v_lw_l_wsb, 2.92167)
plot(v_lw_l_wsb, v_lw_w_wsb)
```




```
# Totoaba demo.
#v_lw_l_tma = seq(l0, linf, by = 100)
#v_lw_w_tma = fn_lw(a, v_lw_l_tma, b)
#plot(v_lw_l_tma, v_lw_w_tma)
```

Weight-Maw Conversion

For a stock of $n_{a,t}$ totoaba cultivated for a years in year t to weight $w_{a,t}$ for a total round weight of $x_{a,t}$, maw yield $y_{a,t}$ depends on wet maw yield ratio $c_{a,t}^{maw}$ and dry yield ratio k.

$y_{a,t}^{maw} = w_{a,t} n_{a,t} c_{a,t}^{maw} k_{dry}^{maw}$

Variable	Definition
y^{maw}	Cohort Dry Maw Yield (Kilograms)
w	Individual Round Weight (Kilograms)
n	Cohort Count
c^{maw}	Yield of maw from round weight.
k^{maw}	Yield of dry maw from wet maw.

```
fn_wm = function(w, n, c, k){ymaw = w * n * c * k}
```

Maw-Price Conversion

Plug the market model in here.

```
#fn_mp = function(w, b0, bw, bq, q, bc, c){pmaw = b0 + w ^ bw + bq * q + bc * c}
fn_mp = function(w, b0, b){pmaw = b0 + w^b}
```

Maw-Revenue Conversion

Fix from regression specification. See Maw-Price Conversion.

For a dry maw yield y^{maw} in kilograms, revenue depends on price.

$R^{maw}_{a,t} = x_{a,t}/n_{a,t} * (\beta_0 + \beta_g(x_{a,t}/n_{a,t}))$

```
fn_mr = function(y, pmaw){rmaw = ymaw * pmaw}
```

Weight-Fillet Conversion

For a stock of totoaba cultivated for a years in year t for a total round weight of $x_{a,t}$, fillet yield $y^{fil}_{a,t}$ depends on fillet yield ratio $c^{fil}_{a,t}$.

Variable	Definition
y^{fil}	Cohort Fillet Yield (Kilograms)
x	Cohort Round Weight (Kilograms)
c^{fil}	Fillet Yield Ratio (%)

```
fn_wf = function(x, c){yfil = x * c}
```

Fillet-Revenue Conversion

For a fillet yield y^{fil} in kilograms, revenue depends on price.

$R^{fil}_{a,t} = y^{fil}_{a,t} * p^{fil}$

```
fn_fr = function(yfil, pfil){rfil = yfil * pfil}
```

Feed Conversion Function

Check in with Goto. Fix.

```
#fn_fcr = function(){}
```

No-Harvest Cost

Fix FCR, then fix this.

```
# Feed costs for a cohort.

fn_ch0 = function(a, c){cstock = a ^ c}
```

Harvest Cost

Cost of restocking a cage after harvest. USD?

```r
# COst of fry plus overhead.

ch1 = 5000
```

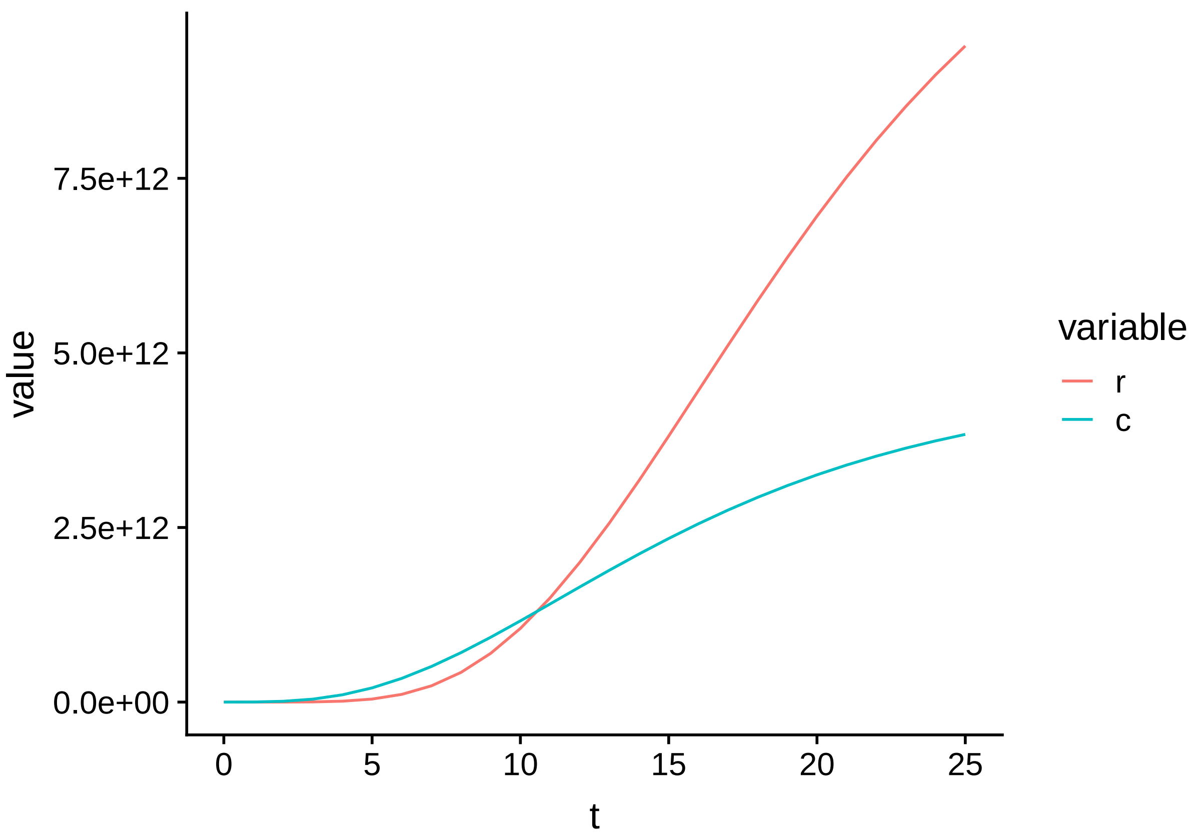
Single Run, No-Harvest Demo

```r
t = seq(0, 25)
l = fn_vb(1465.3822, 0.1280, t, -0.2805)
w = fn_lw(0.000015491, l, 2.92167)
ymaw = fn_wm(w, 1000, 0.40, 0.02)
pmaw = fn_mp(w, 25, 1.75)
rmaw = fn_mr(ymaw, pmaw)
yfil = fn_wf(w, 0.50)
rfil = fn_fr(yfil, 2.50)
r = rfil + rmaw
c = (10000 * w)^1.5

demo_h0 = data.frame(t, r, c)

demo_h0 = melt(demo_h0, id = 1)

ggplot(demo_h0, aes(t, value, colour = variable)) +
  geom_path()
```



Single Run, Harvest Demo