Osoyoos Spawner Abundance

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Summary

Data for Osoyoos Lake spawner abundance 2001 to 2020 is available as Peak Life plus Dead (PLD) and as Area Under the Curve (AUC). One data point is corrected. Simple statistics and plots are exampled. Low survival from Wells dam to spawning grounds (Osoyoos River above Osoyoos Lake, near Oliver BC) in 2015 is noted. PLD and AUC are tightly correlated, as expected because these are, ostensibly, height and integral of distribution of spawner abundance by time. These indices are combined as the first principle component ($r^2 = 98.4\%$), which is then scaled and located to correspond to AUC statistics (mean, stdev). The result is saved for subsequent analyses such as spawner to parr survival.

Source

Mathieu, C, D. Machin, K. Hyatt, T. White, S. Reimer, E. Hegerat, C. Louie, K. Alex. 2020. **Okanagan Fish and Water Management Tools (FWMT) year 2020-2021.** Prepared for the FWMT Steering Committee and Douglas County PUD. Prepared by Okanagan Nation Alliance Fisheries Department, Westbank, BC.

```
knitr::opts_chunk$set(echo=TRUE)
library(magrittr); library(knitr);
```

Data

Copied from source above.
PLD cannot exceed AUC, given these approximate height and integral of a Gaussian distribution. Thus 2019 values are assumed reversed.

	Year	Wells	PeakLiveDead	AreaUnderCurve
20	2001	74486	26996	41922
19	2002	10659	2789	4898
18	2003	29374	10390	17753
17	2004	78053	21308	41571
16	2005	55559	24161	31536
15	2006	22075	18086	20819
14	2007	22273	8283	13504
13	2008	165334	72598	127602
12	2009	134937	44328	64141
11	2010	291764	96885	209974
10	2011	111507	24228	77650
9	2012	326102	49831	94071
8	2013	129993	23341	36557
7	2014	490802	83446	146701
6	2015	186964	6374	10443
5	2016	216031	43277	55190
4	2017	42299	4795	10040
3	2018	153637	17737	31001
2	2019	49862	6926	13108
1	2020	226107	28079	48138

Basic Statistics

Using a local function by the author: Simple.

```
Simple(escapement) # default: print=TRUE
```

```
  Year     Wells  PeakLiveDead AreaUnderCurve
```

```
n    20      20     20          20
m    2010    140891 30693       54831
s    5.92    123019 26877       53427
se   1.32    27508  6010        11947
cv   0.00294 0.873  0.876       0.974
md   2010    120750 23751       39064
mad  7.41    110705 23939       37537
min  2001    10659  2789        4898
q1   2006    47971  9863        16691
q3   2015    194231 43540       67518
max  2020    490802 96885       209974
```

```
a = escapement[ ,3]/escapement[ ,4]
cat('\n ratio, PLD to AUC: \n')
```

```
 ratio, PLD to AUC:
```

```
Simple(a)
```

| n	m	s	se	cv	md	mad	min	q1	q3	max
20	0.594	0.122	0.0273	0.206	0.578	0.0816	0.312	0.529	0.64	0.869

note the mean of PLD/AUC = 0.59 is too large, only possible if stdev of spawner abundance is < 1 day (note dnorm(0,0,1) = 0.4;dnorm(0,0,0.67) = 0.59). In fact that stdev is ~5 days. The discrepancy might be AUC is live only.

Also note AUC / Wells for 2015 is an outlier: 0.056 (94.4% loss) in comparison to mean excluding 2015, 0.47 (.21); 1.9 stdev below mean, one in 35 years.

plot AUC against Wells.

```
with(escapement, {
    x=1e-6*Wells;
    y=1e-6*AreaUnderCurve;
    par(tcl=0.2,mgp=c(1.25,.25,0));   # tics inside, axis labels close
    plot(y~x, pch=20, cex=.6, xlab="Wells (millions)", ylab='AUC (millions)');
    abline(0,1);
    abline(0, 209974/291764, lty="dashed", col="blue")
```

```
})
```
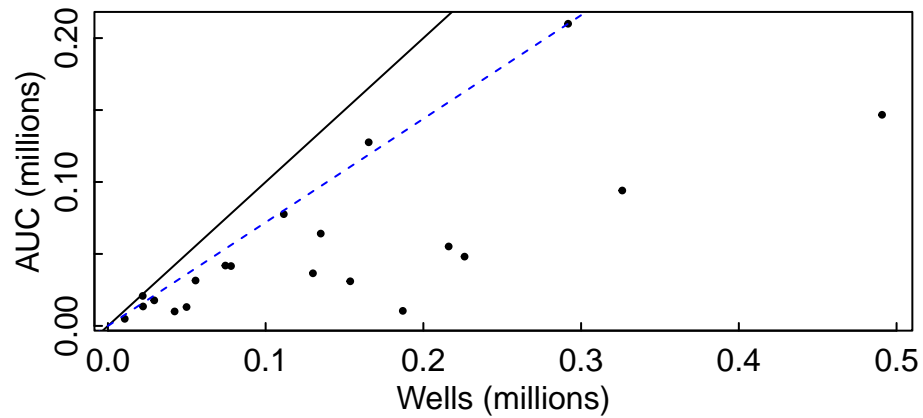


```
#      xlim= c(0, max(Wells)), ylim=c(0,max(AreaUnderCurve)) )
```

Note typically good survival is about 0.72 (dashed line) as typified by 2010. Modal survival is approximately 0.3, typified by 2014.

plot PLD vs AUC

peak live plus dead at Oliver against *area under curve* (AUC) of spawners observed.

```
a <- lm(PeakLiveDead~0 + AreaUnderCurve, data=escapement)
with(escapement, {
    y=1e-6*PeakLiveDead;
    x=1e-6*AreaUnderCurve;
    par(tcl=0.2,mgp=c(1.25,.25,0));    # tics inside, axis labels close
    plot(y~x, pch=20, cex=.6,
         xlab='AUC (millions)',ylab="Peak Live + Dead (millions)");
    # abline(0,1);
    abline(a, lty='dashed', col="blue")
})
```
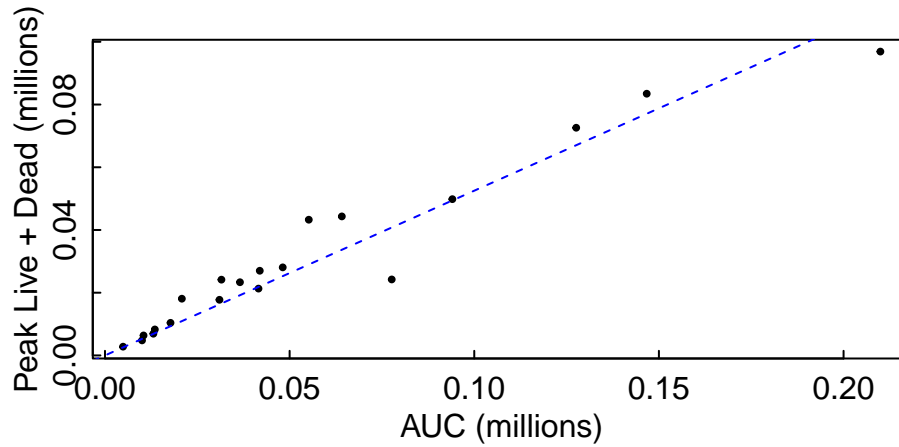
```
#      xlim= c(0, max(Wells)), ylim=c(0,max(AreaUnderCurve)) )
```

The low outlier is 2011, PLD/AUC is 0.31 compared to regression through origin slope of 0.526 (sd=0.022) indicated by blue dashed line.

principle components

Assuming that PLD and AUC estimate the same abundance of spawners, with comparable accuracy each year, these indices can be combined as their principle component. This will tend to reduce the effects an error or outlier in either.

```
pc <-princomp(~PeakLiveDead + AreaUnderCurve, data=escapement, cor=TRUE)
summary(pc)
```

```
Importance of components:
                        Comp.1      Comp.2
Standard deviation     1.4029501 0.17813237
Proportion of Variance 0.9841344 0.01586557
Cumulative Proportion  0.9841344 1.00000000
```

```
spawnersPC = data.frame(Year=escapement$Year, PC1 =pc$scores[,1],PC2 =pc$scores[,2])
if(!file.exists("spawnersPC.Rdata")) {
    saveRDS(spawnersPC, file="spawnersPC.Rdata" )
}
kable(spawnersPC, row.names = FALSE )
```

Year	PC1	PC2
2001	-0.2750784	0.0754992
2002	-1.4312364	-0.0751716
2003	-1.0515080	-0.0445557
2004	-0.4333796	-0.0732696
2005	-0.4926330	0.1400046
2006	-0.8021388	0.1215480
2007	-1.1660784	-0.0437329
2008	2.1192831	0.1429877
2009	0.4944692	0.2416295
2010	3.8933744	-0.3199561
2011	0.1353510	-0.4843623
2012	1.0494257	-0.0162444
2013	-0.4465876	0.0496911
2014	2.6714434	0.1764629
2015	-1.2591725	-0.0536972
2016	0.3445554	0.3348044
2017	-1.3072664	-0.0908466
2018	-0.6732993	-0.0261324
2019	-1.2080848	-0.0749849
2020	-0.1614391	0.0203262

The resulting PC1 is equivalent to $r^2 = 98.4\%$.

```
lim=range(pc$scores)
par(tcl=0.2,mgp=c(1.25,.25,0));   # tics inside, axis labels close
plot(pc$scores, xlim=lim, ylim=lim, pch=20)
abline(h=0,v=0, col="blue")
```
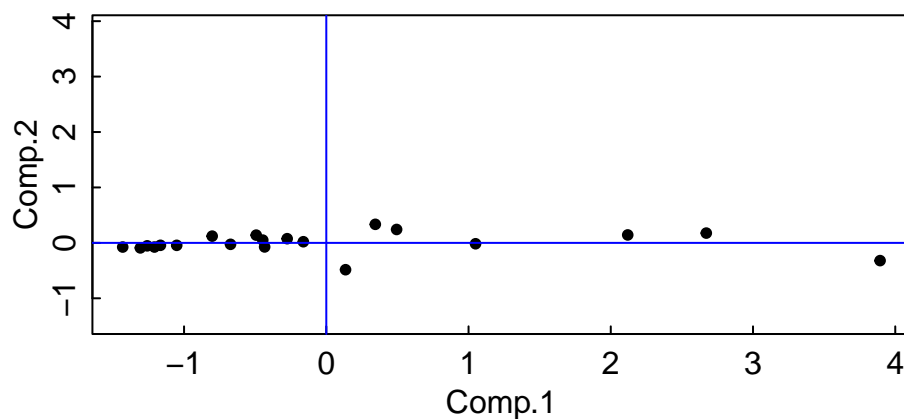
```
#biplot(pc)
```

This is a calibration instead of regression (prediction). The major assumption is that observations variance is similar for both variables.

The plot of PC2 *vs* PC1 emphasizes how rows 10 and 11 (years 2011 and 2012) deviate from pattern of remaining points (the residuals are *PC2*).

Recalibrate PC1 to scale of AUC

PC1 has mean mean 0 and stdev 1.44, with range -1.43 to 3.89. To eliminate negative spawners, this is adjusted to the mean 54,522 and stdev 53,698 of AUC 2001-2020 (range: 4,898 to 209,974). This is the value used for spawner abundance (without attention to fecundity via length frequencies and sex ratios) in subsequent analyses.

Saved as file *'data/OSO_spawners_PC.RData'*.

```
a <- (spawnersPC[,2] * 53698/sd(spawnersPC[,2])) + 54522
Simple(a)
```

```
  n     m     s    se    cv    md   mad   min    q1    q3   max
 20 54522 53698 12007 0.985 38108 41322  1128 14226 68774 2e+05
```

```
spawners = data.frame(Year=spawnersPC$Year, spawners=round(a,0))
if(!file.exists('data/OSO_spawners_PC.RData')){ # does not exist
    saveRDS(spawners, file = 'data/OSO_spawners_PC.RData')
}
kable(spawners)
```

Year	spawners
2001	44260
2002	1128
2003	15295
2004	38354
2005	36144
2006	24597
2007	11020
2008	133584
2009	72969

Year	spawners
2010	199768
2011	59571
2012	93672
2013	37862
2014	154183
2015	7547
2016	67376
2017	5753
2018	29404
2019	9453
2020	48499