



## MEMORANDUM

TO: Distribution DATE: January 24, 2020

FROM: Nick DeCovich, Northern Cook Inlet Area  
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Division of Sport Fish, Region II SUBJECT: Outlook for the 2020  
Deshka River king  
salmon run, and  
accuracy of the 2019  
forecast

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The point estimate of the preseason forecast for the 2020 Deshka River king salmon total run is 10,570 age 1.2-1.4 fish, which is below the sustainable escapement goal (SEG) of 13,000-28,000. The 80% prediction interval for the total run forecast is 1,860 to 19,280 fish (Table 1). This forecast estimate is 35% less than the ten-year (2010 – 2019) average run of 16,274 age 1.2-1.4 fish, 66% less than the long-term (1979 – 2019) average run of 30,865 fish, and 25% greater than the forecast for the 2019 run (8,466).

The forecast for 2020 is the sum of individual age class forecasts. We examined three classes of models: sibling relationships, Ricker spawner-recruit relationships, and recent year moving averages. The models chosen were those with statistically significant parameters that have the greatest past reliability (accuracy and precision). Specifically, the model estimates selected for each age class for inclusion in the 2020 forecast were those with the minimum recent five year's mean absolute deviation (MAD). We calculated the MAD as the mean of the absolute distance between hindcasted estimates for the previous five years and the actual returns for each age class. The hindcasts were produced for each return year as one step ahead predictions using the estimates from all prior years.

The univariate time series model was selected for age-1.2 fish; the five-year moving average was selected for age-1.3 fish; and the univariate time series model also selected for age-1.4 fish (Table 1). For a description of each model considered see Table 2.

Estimates of age-1.1 'jack' king salmon at the Deshka weir were very low in the previous 3 decades (1980's – early 2000's). In many years, zero to a few hundred fish of this age class were estimated through the weir. For this reason, past years forecasts have focused on age 1.2 – 1.4 fish. In recent years, there has been an increase in the number of jacks estimated at the weir, and efforts are underway to evaluate how this phenomenon could impact future production (Table 3).

The preliminary estimate of last year's (2019) Deshka River king salmon total run is 8,804 fish age-1.2, 1.3, and 1.4 (Table 3). The forecast estimate of total run for 2019 for these age classes was 8,466, a difference of only 4%. The average difference between the forecast total run and

actual total run, for years 1999–2019 is -16% (Table 4). The 2019 actual total run was 62% less than the ten-year (2009 – 2018) average run of 16,647.

The age 2019 run completed the return of the 2013 brood year (BY). The 2013 BY produced a total return of 8,781 king salmon (return per spawner = 0.48). This was less productive than the 2012 brood year, which had a return-per-spawner of 1.62.

There is uncertainty in the total 2020 Deshka River king salmon forecast estimate. One pattern to this uncertainty is that the models used tend to over-forecast when runs are declining and under-forecast when they are rebounding. The Deshka king salmon forecast has differed by 12% to -51% from the actual run in the past ten years (-19% average).

The best way to consider this salmon forecast is in terms of 3 broad categories: approximately average run, below average run, or above average run. The 2020 forecast gives the expectation of a run in the below average category.

Table 1.– Forecast king salmon abundance of major age classes for the Deshka River in 2020 using various models, and the relative performance of each model to the previous 5 years of actual runs as measured by MAD (mean absolute deviation).

| Model                  | Forecast<br>2020 | Model<br>chosen | 5-year<br>MAD |
|------------------------|------------------|-----------------|---------------|
| <b>Age 1.2</b>         |                  |                 |               |
| 5-year moving average  | 3,198            |                 | 3,469         |
| Exponential smoothing  | 1,866            |                 | 4,088         |
| Univariate time series | 3,083            | *               | 3,147         |
| Sibling                | <sup>a</sup>     |                 |               |
| Ricker                 | 3,460            |                 | 3,533         |
| <b>Age 1.3</b>         |                  |                 |               |
| 5-year moving average  | 7,306            | *               | 2,179         |
| Exponential smoothing  | 6,138            |                 | 2,970         |
| Univariate time series | 9,451            |                 | 3,743         |
| Sibling                | 2,395            |                 | 3,147         |
| Ricker                 | 10,913           |                 | 3,588         |
| <b>Age 1.4</b>         |                  |                 |               |
| 5-year moving average  | 678              |                 | 1,194         |
| Exponential smoothing  | 227              |                 | 900           |
| Univariate time series | 181              | *               | 858           |
| Sibling                | 447              |                 | 1,259         |
| Ricker                 | <sup>b</sup>     |                 |               |

Total forecast 10,570 (1,860 - 19,280, 80% PI)

<sup>a</sup>There was no significant sibling relationship with 1.2 age fish.

<sup>b</sup>The Ricker model was insignificant for 1.4 age fish.

Table 2. – Brief description of statistical models used in forecasting the Deshka River king salmon run for 2020. All calculations done using R software.

| Model                  | Description  |
|------------------------|--|
| 5-year moving average  | A moving average on the natural log of abundance in each age class.  |
| Exponential smoothing  | A weighted moving average on the natural log of abundance in each class.   |
| Univariate time series | AutoRegressive Integrated Moving Average analysis on the natural log of abundance in each age class.                                     |
| Sibling model          | Regression between the natural logs of annual abundance in an age class and the most recent return of siblings from the same brood year. |
| Ricker Model           | Ricker-style regression for each age class.  |

Table 3. – Estimate of Deshka River king salmon by age class in the run for years 1979 – 2019.

| Run Year | Number per Age Class |        |        |        |     | Total Run     | Total Run |
|----------|----------------------|--------|--------|--------|-----|---------------|-----------|
|          | 1.1                  | 1.2    | 1.3    | 1.4    | 1.5 | age 1.2 - 1.4 | all ages  |
| 1979     | 0                    | 4,449  | 38,131 | 20,972 | 0   | 63,552        | 63,552    |
| 1980     | 0                    | 3,900  | 19,891 | 15,211 | 0   | 39,002        | 39,002    |
| 1981     | 0                    | 2,613  | 14,893 | 8,622  | 0   | 26,128        | 26,128    |
| 1982     | 0                    | 5,442  | 18,838 | 18,001 | 0   | 42,282        | 42,282    |
| 1983     | 0                    | 10,300 | 22,543 | 16,191 | 0   | 49,034        | 49,034    |
| 1984     | 0                    | 7,651  | 21,154 | 16,203 | 0   | 45,008        | 45,008    |
| 1985     | 0                    | 7,214  | 20,841 | 20,274 | 7   | 48,328        | 48,336    |
| 1986     | 10                   | 18,330 | 22,105 | 14,970 | 27  | 55,405        | 55,443    |
| 1987     | 5                    | 6,740  | 23,345 | 12,207 | 6   | 42,291        | 42,302    |
| 1988     | 493                  | 6,069  | 12,611 | 30,149 | 995 | 48,829        | 50,317    |
| 1989     | 506                  | 8,152  | 8,314  | 14,970 | 414 | 31,436        | 32,357    |
| 1990     | 445                  | 8,212  | 21,165 | 18,930 | 147 | 48,307        | 48,899    |
| 1991     | 0                    | 4,634  | 10,715 | 15,564 | 0   | 30,913        | 30,914    |
| 1992     | 3,032                | 5,639  | 8,696  | 10,331 | 6   | 24,666        | 27,703    |
| 1993     | 1                    | 4,650  | 10,207 | 7,172  | 4   | 22,029        | 22,034    |
| 1994     | 3                    | 1,698  | 4,533  | 4,260  | 99  | 10,490        | 10,592    |
| 1995     | 105                  | 3,961  | 3,026  | 3,200  | 161 | 10,188        | 10,454    |
| 1996     | 6                    | 7,022  | 5,486  | 1,962  | 0   | 14,470        | 14,475    |
| 1997     | 74                   | 6,062  | 23,592 | 6,054  | 0   | 35,709        | 35,783    |
| 1998     | 0                    | 10,593 | 15,572 | 10,306 | 115 | 36,470        | 36,585    |
| 1999     | 0                    | 10,079 | 14,338 | 8,384  | 67  | 32,801        | 32,868    |
| 2000     | 1                    | 4,468  | 32,678 | 4,210  | 0   | 41,356        | 41,357    |
| 2001     | 477                  | 7,934  | 15,444 | 9,372  | 1   | 32,751        | 33,229    |
| 2002     | 533                  | 8,791  | 18,776 | 5,221  | 0   | 32,788        | 33,321    |
| 2003     | 472                  | 16,631 | 22,489 | 6,520  | 0   | 45,640        | 46,112    |
| 2004     | 660                  | 11,877 | 43,550 | 9,898  | 0   | 65,325        | 65,985    |
| 2005     | 538                  | 12,864 | 25,464 | 5,220  | 0   | 43,549        | 44,087    |
| 2006     | 0                    | 8,660  | 20,987 | 8,426  | 0   | 38,074        | 38,074    |
| 2007     | 0                    | 2,141  | 16,818 | 4,689  | 0   | 23,648        | 23,648    |
| 2008     | 0                    | 1,520  | 3,686  | 4,502  | 0   | 9,708         | 9,708     |
| 2009     | 0                    | 8,376  | 3,019  | 1,137  | 0   | 12,531        | 12,531    |
| 2010     | 195                  | 4,542  | 15,182 | 1,882  | 0   | 21,605        | 21,800    |
| 2011     | 504                  | 5,856  | 14,042 | 1,511  | 0   | 21,410        | 21,913    |
| 2012     | 654                  | 8,611  | 4,087  | 2,398  | 0   | 15,096        | 15,750    |
| 2013     | 770                  | 4,197  | 11,460 | 3,219  | 0   | 18,876        | 19,647    |
| 2014     | 1,526                | 6,960  | 6,982  | 2,127  | 0   | 16,068        | 17,594    |
| 2015     | 2,830                | 7,020  | 12,621 | 3,287  | 0   | 22,928        | 25,759    |
| 2016     | 4,024                | 10,828 | 8,639  | 1,743  | 0   | 21,209        | 25,233    |
| 2017     | 1,101                | 1,501  | 8,826  | 1,174  | 0   | 11,500        | 12,601    |
| 2018     | 3,352                | 2,148  | 3,008  | 86     | 0   | 5,242         | 8,594     |
| 2019     | 951                  | 1,364  | 7,192  | 248    | 0   | 8,804         | 9,755     |

Table 4. – Accuracy of the Deshka River king salmon outlook for the three major age classes, 1999–2019.

| Return year                            | Forecast run | Forecast category | Actual run | Forecast difference by major age class (forecast-actual) |         |         |         |                | Relative difference |
|--|--------------|-------------------|------------|--|---------|---------|---------|----------------|---------------------|
|  |              |                   |            | Actual run   | Age 1.2 | Age 1.3 | Age 1.4 | Overall effect |                     |
| 1999                                   | 26,810       | average           | 32,801     | above  | -4,142  | -94     | -1,755  | underforecast  | 22%                 |
| 2000                                   | 33,337       | above             | 41,356     | above  | 3,694   | -17,421 | 5,708   | underforecast  | 24%                 |
| 2001                                   | 40,753       | above             | 32,751     | above  | 618     | -5,632  | 13,017  | overforecast   | -20%                |
| 2002                                   | 43,805       | above             | 32,788     | above  | 1,045   | 5,714   | 4,258   | overforecast   | -25%                |
| 2003                                   | 41,041       | above             | 45,640     | above  | -8,323  | -696    | 4,420   | underforecast  | 11%                 |
| 2004                                   | 60,833       | above             | 65,325     | above  | -2,344  | -228    | -1,920  | underforecast  | 7%                  |
| 2005                                   | 48,687       | above             | 43,549     | above  | -4,519  | 3,267   | 6,391   | overforecast   | -11%                |
| 2006                                   | 49,071       | above             | 38,074     | above  | -542    | 12,264  | -724    | overforecast   | -22%                |
| 2007                                   | 37,007       | above             | 23,648     | average  | 6,626   | 4,391   | 2,342   | overforecast   | -36%                |
| 2008                                   | 20,268       | average           | 9,708      | below  | 6,420   | 2,040   | 2,100   | overforecast   | -52%                |
| 2009                                   | 20,593       | average           | 12,531     | below  | 1,151   | 4,194   | 2,716   | overforecast   | -39%                |
| 2010                                   | 30,775       | average           | 21,605     | average  | 4,990   | 3,165   | 1,014   | overforecast   | -30%                |
| 2011                                   | 21,080       | average           | 21,410     | average  | 445     | -3,887  | 3,113   | underforecast  | 2%                  |
| 2012                                   | 21,665       | average           | 15,096     | below  | -3,983  | 9,514   | 1,038   | overforecast   | -30%                |
| 2013                                   | 26,791       | average           | 18,876     | below  | 3,215   | 6,748   | -2,048  | overforecast   | -30%                |
| 2014                                   | 19,063       | below             | 16,068     | below  | -463    | 1,580   | 1,876   | overforecast   | -16%                |
| 2015                                   | 20,418       | average           | 22,928     | average  | -793    | -1,960  | 243     | underforecast  | 12%                 |
| 2016                                   | 24,638       | average           | 21,209     | average  | -4,002  | 4,194   | 3,236   | overforecast   | -14%                |
| 2017                                   | 17,813       | below             | 11,500     | below  | 5,311   | -427    | 1,428   | overforecast   | -35%                |
| 2018                                   | 10,595       | below             | 5,242      | below  | 4,757   | -1,744  | 2,340   | overforecast   | -51%                |
| 2019                                   | 8,466        | below             | 8,804      | below  | 2,530   | -3,668  | 800     | underforecast  | 4%                  |
| Average relative difference, 1999-2019 |              |                   |            |  |         |         |         |                | -16%                |

<sup>a</sup>Average category is defined as +/- 25% of the the 1999-2019 actual run average of 25,755 age 1.2-1.4 fish.