



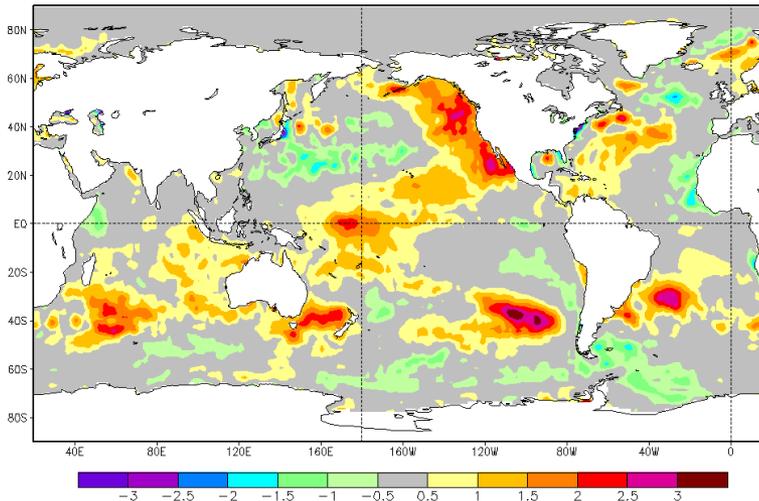
# 6.2 Ocean Indicators Relative to Protected Species

**NOAA**  
**FISHERIES**

**NWFSC**

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Sea Surface Temperature Anomaly (°C), Base Period 1971–2000  
Week of 25 FEB 2015



May 5<sup>th</sup>, 2015

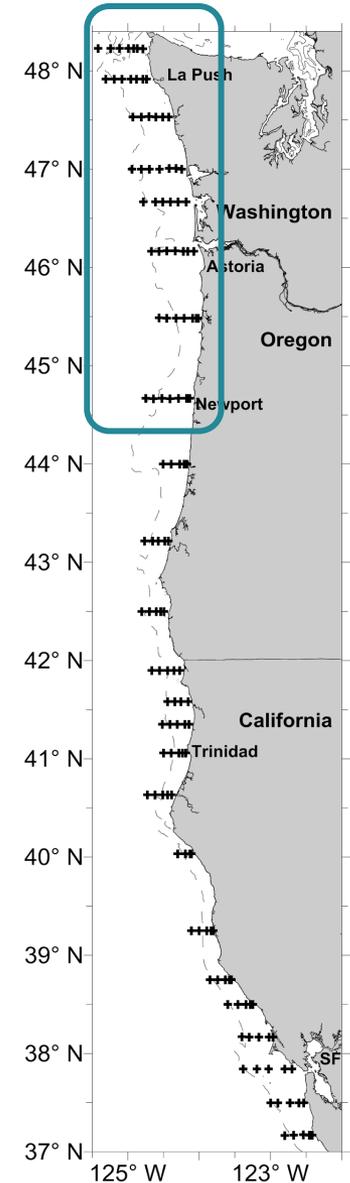
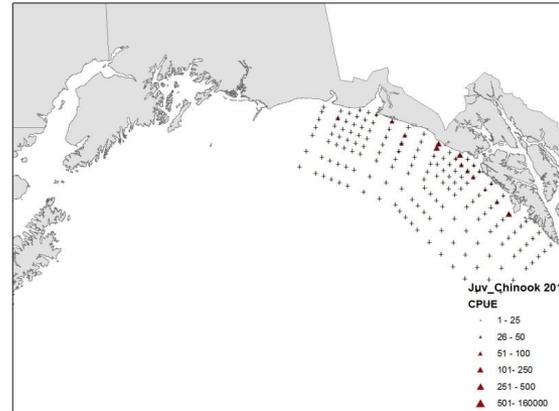
# Outline

- Indicators (of ocean conditions)
- Forecasting
- Spatial distribution and future directions
- Data Gaps

# Observations

Juvenile salmon sampling:

- May (2006 - 2012, 2015)
  - June (1998 - present)
  - September (1998 - 2012)
- 
- Measure physical and biological conditions
  - Focus on distribution & abundance of juvenile salmonids along with metrics of growth & condition



# Indicators

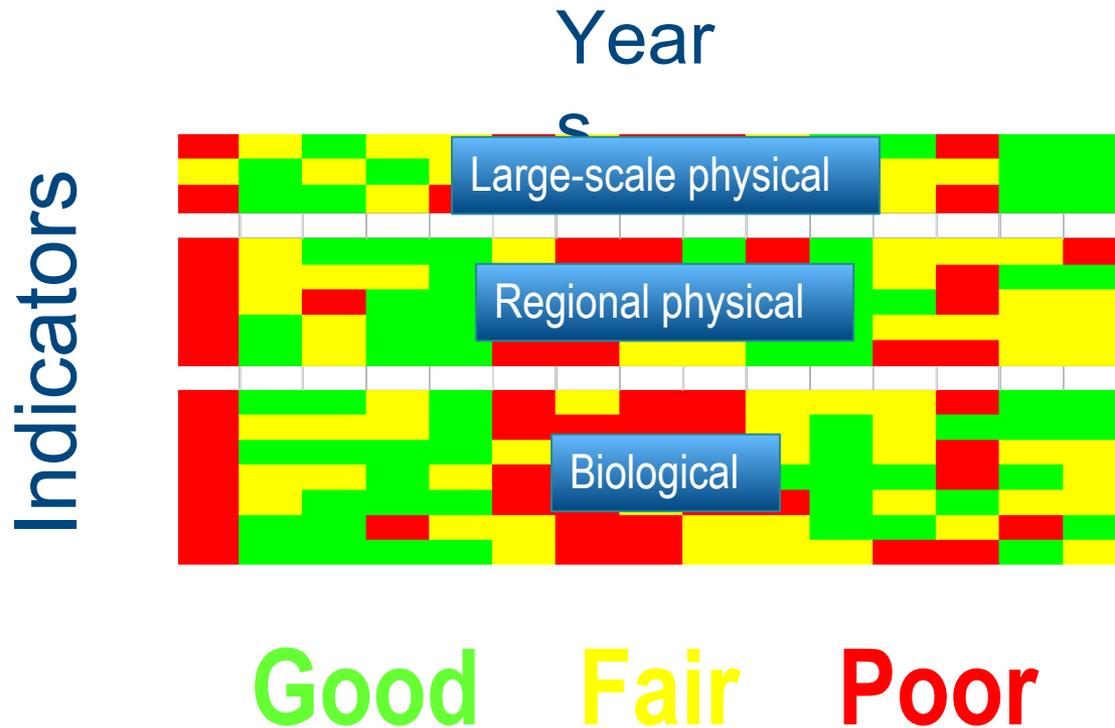
(of ocean conditions relative to salmon)

- **Basin Scale:**
  - PDO, NPGO, ONI
- **Local-Regional Scale SST:**
  - SST offshore and SST mid-shelf in summer; SST in winter
- **Coastal upwelling:**
  - spring transition; length of upwelling season, upwelling in spring; deep T and S in mid-shelf waters
- **Copepods:**
  - species richness, northern copepod biomass, copepod community structure index, date of biological spring transition
- **Ichthyoplankton:**
  - density in Jan-Mar of the larvae of species of fish that salmon eat
- **Salmon:**
  - catches of spring Chinook in June and coho in September

<http://www.nwfsc.noaa.gov/oceanconditions>



# General Characterization of Ocean Conditions



<http://www.nwfsc.noaa.gov/oceanconditions>

# Stoplight Chart

<i>Ecosystem Indicators</i>	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PDO (December-March)	16	6	3	12	7	17	11	15	13	9	5	1	14	4	2	8	10
PDO (May-September)	10	4	6	5	11	15	14	16	12	13	2	9	7	3	1	8	17
ONI Jan-June	17	2	1	5	13	14	12	15	7	11	3	9	16	4	5	7	9
46050 SST (May-Sept)	15	8	3	4	1	7	17	14	5	16	2	9	6	10	11	12	13
NH 05 Upper 20 m T winter prior (Nov-Mar) *	17	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2
NH 05 Upper 20 m T (May-Sept) *	13	10	12	4	1	3	17	15	7	8	2	5	11	9	6	14	16
NH 05 Deep Temperature (May-Sept) *	17	6	8	4	1	9	12	14	10	5	2	7	13	11	3	16	15
NH 05 Deep Salinity (May-Sept) *	17	3	7	4	5	13	14	8	6	1	2	11	15	10	9	12	16
Copepod Richness Anomaly *	17	2	1	7	6	13	12	16	14	11	9	10	15	4	5	3	8
N. Copepod Biomass Anomaly *	16	13	9	10	3	15	12	17	14	11	6	8	7	1	2	4	5
S. Copepod Biomass Anomaly *	17	2	5	4	3	13	14	16	12	10	1	7	15	9	8	6	11
Biological Transition *	17	11	6	7	8	12	10	16	15	3	1	2	14	4	9	5	13
Winter Ichthyoplankton *	17	8	2	4	6	15	14	10	13	12	1	9	3	11	7	5	16
Chinook Juv Catches (June) *	16	4	5	14	10	12	15	17	11	8	1	6	7	13	3	2	9
Coho Juv Catches (June) *	16	7	11	5	6	2	13	17	14	3	4	8	9	12	15	1	10
Mean of Ranks	15.9	6.5	5.8	6.6	5.8	11.6	13.5	14.5	11.1	8.4	2.8	7.3	11.2	7.3	5.9	7.3	11.3
RANK of the Mean Rank	17	5	2	6	2	14	15	16	11	10	1	8	12	7	4	8	13
Principle Component Scores (PC1)	6.70	-1.93	-2.55	-1.71	-1.96	1.81	2.94	4.41	1.02	-0.66	-4.70	-1.30	1.45	-1.47	-2.11	-1.35	1.42
Principle Component Scores (PC2)	-0.72	0.09	0.24	-1.10	-1.81	-1.36	2.17	-0.97	-1.20	0.38	-1.26	0.49	-1.11	1.08	0.57	1.90	2.62
<b>Ecosystem Indicators not included in the mean of ranks or statistical analyses</b>																	
Physical Spring Trans (UI Based)	3	6	16	13	4	10	12	17	10	1	5	2	7	9	14	8	15
Physical Spring Trans (Hydrographic)	16	3	12	7	5	11	13	17	6	8	1	8	15	3	10	2	14
Upwelling Anomaly (Apr-May)	7	1	14	3	6	11	10	17	7	2	4	5	12	14	12	9	16
Length of Upwelling Season (UI Based)	6	2	15	9	1	10	8	17	5	3	7	3	12	14	12	11	16
NH 05 SST (May-Sept) *	10	6	5	4	1	3	16	14	8	12	2	15	9	7	11	13	16
Copepod Community Structure *	17	5	4	8	1	13	14	16	15	10	2	6	12	9	7	3	11
Coho Juv Catches (Sept) *	11	2	1	4	3	6	12	14	8	9	7	15	13	5	10	NA	NA

<http://www.nwfsc.noaa.gov/oceanconditions>

\* Collected during NWFSC cruises

# Stoplight Chart

## DFO - WCVI

AFSC

Environmental Variables	1998	1999	2005	2008	2009	2010	2011	2012	2013	2014
PDO (May-Sep)	10	4	16	2	9	7	3	1	8	17
NPGO (May-Sep)	14	5	17	2	11	6	7	4	12	15
ENSO (May-Sep)	8	2	11	6	17	1	5	14	4	15
Mean SST - WCVI (Amphitrite) - Mar-Jun	16	1	17	6	9	13	10	2	7	14
WCVI Coho Summer Growth	16	2	17	8	14	7	15	6	13	1
Mean Rank	12.8	2.8	15.6	4.8	12.0	6.8	8.0	5.4	8.8	12.4
Rank of Mean Ranks	16	1	17	2	13	6	7	3	10	14

Pink salmon parent brood year				Chronological ecosystem variables											Pink salmon harvest																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
Brood year (BY)	SEAK pink harvest (M)	Pink escapement opportunity (% Northern harvest, 0=0% to 40% Northern harvest, 100% Northern harvest, 0=0% to 100% Northern harvest)	SEAK pink escapement index	Catches off/yr (BY lagged 1 yr later)	AOAA <sub>1</sub>	AOAA <sub>2</sub>	NOAA <sub>1</sub>	NOAA <sub>2</sub>	NOAA <sub>3</sub>	NOAA <sub>4</sub>	NOAA <sub>5</sub>	NOAA <sub>6</sub>	NOAA <sub>7</sub>	NOAA <sub>8</sub>	NOAA <sub>9</sub>	NOAA <sub>10</sub>	NOAA <sub>11</sub>	NOAA <sub>12</sub>	NOAA <sub>13</sub>	NOAA <sub>14</sub>	NOAA <sub>15</sub>	NOAA <sub>16</sub>	NOAA <sub>17</sub>	NOAA <sub>18</sub>	NOAA <sub>19</sub>	NOAA <sub>20</sub>	NOAA <sub>21</sub>	NOAA <sub>22</sub>	NOAA <sub>23</sub>	NOAA <sub>24</sub>	NOAA <sub>25</sub>	NOAA <sub>26</sub>	NOAA <sub>27</sub>	NOAA <sub>28</sub>	NOAA <sub>29</sub>	NOAA <sub>30</sub>	NOAA <sub>31</sub>	NOAA <sub>32</sub>	NOAA <sub>33</sub>	NOAA <sub>34</sub>	NOAA <sub>35</sub>	NOAA <sub>36</sub>	NOAA <sub>37</sub>	NOAA <sub>38</sub>	NOAA <sub>39</sub>	NOAA <sub>40</sub>	NOAA <sub>41</sub>	NOAA <sub>42</sub>	NOAA <sub>43</sub>	NOAA <sub>44</sub>	NOAA <sub>45</sub>	NOAA <sub>46</sub>	NOAA <sub>47</sub>	NOAA <sub>48</sub>	NOAA <sub>49</sub>	NOAA <sub>50</sub>	NOAA <sub>51</sub>	NOAA <sub>52</sub>	NOAA <sub>53</sub>	NOAA <sub>54</sub>	NOAA <sub>55</sub>	NOAA <sub>56</sub>	NOAA <sub>57</sub>	NOAA <sub>58</sub>	NOAA <sub>59</sub>	NOAA <sub>60</sub>	NOAA <sub>61</sub>	NOAA <sub>62</sub>	NOAA <sub>63</sub>	NOAA <sub>64</sub>	NOAA <sub>65</sub>	NOAA <sub>66</sub>	NOAA <sub>67</sub>	NOAA <sub>68</sub>	NOAA <sub>69</sub>	NOAA <sub>70</sub>	NOAA <sub>71</sub>	NOAA <sub>72</sub>	NOAA <sub>73</sub>	NOAA <sub>74</sub>	NOAA <sub>75</sub>	NOAA <sub>76</sub>	NOAA <sub>77</sub>	NOAA <sub>78</sub>	NOAA <sub>79</sub>	NOAA <sub>80</sub>	NOAA <sub>81</sub>	NOAA <sub>82</sub>	NOAA <sub>83</sub>	NOAA <sub>84</sub>	NOAA <sub>85</sub>	NOAA <sub>86</sub>	NOAA <sub>87</sub>	NOAA <sub>88</sub>	NOAA <sub>89</sub>	NOAA <sub>90</sub>	NOAA <sub>91</sub>	NOAA <sub>92</sub>	NOAA <sub>93</sub>	NOAA <sub>94</sub>	NOAA <sub>95</sub>	NOAA <sub>96</sub>	NOAA <sub>97</sub>	NOAA <sub>98</sub>	NOAA <sub>99</sub>	NOAA <sub>100</sub>	NOAA <sub>101</sub>	NOAA <sub>102</sub>	NOAA <sub>103</sub>	NOAA <sub>104</sub>	NOAA <sub>105</sub>	NOAA <sub>106</sub>	NOAA <sub>107</sub>	NOAA <sub>108</sub>	NOAA <sub>109</sub>	NOAA <sub>110</sub>	NOAA <sub>111</sub>	NOAA <sub>112</sub>	NOAA <sub>113</sub>	NOAA <sub>114</sub>	NOAA <sub>115</sub>	NOAA <sub>116</sub>	NOAA <sub>117</sub>	NOAA <sub>118</sub>	NOAA <sub>119</sub>	NOAA <sub>120</sub>	NOAA <sub>121</sub>	NOAA <sub>122</sub>	NOAA <sub>123</sub>	NOAA <sub>124</sub>	NOAA <sub>125</sub>	NOAA <sub>126</sub>	NOAA <sub>127</sub>	NOAA <sub>128</sub>	NOAA <sub>129</sub>	NOAA <sub>130</sub>	NOAA <sub>131</sub>	NOAA <sub>132</sub>	NOAA <sub>133</sub>	NOAA <sub>134</sub>	NOAA <sub>135</sub>	NOAA <sub>136</sub>	NOAA <sub>137</sub>	NOAA <sub>138</sub>	NOAA <sub>139</sub>	NOAA <sub>140</sub>	NOAA <sub>141</sub>	NOAA <sub>142</sub>	NOAA <sub>143</sub>	NOAA <sub>144</sub>	NOAA <sub>145</sub>	NOAA <sub>146</sub>	NOAA <sub>147</sub>	NOAA <sub>148</sub>	NOAA <sub>149</sub>	NOAA <sub>150</sub>	NOAA <sub>151</sub>	NOAA <sub>152</sub>	NOAA <sub>153</sub>	NOAA <sub>154</sub>	NOAA <sub>155</sub>	NOAA <sub>156</sub>	NOAA <sub>157</sub>	NOAA <sub>158</sub>	NOAA <sub>159</sub>	NOAA <sub>160</sub>	NOAA <sub>161</sub>	NOAA <sub>162</sub>	NOAA <sub>163</sub>	NOAA <sub>164</sub>	NOAA <sub>165</sub>	NOAA <sub>166</sub>	NOAA <sub>167</sub>	NOAA <sub>168</sub>	NOAA <sub>169</sub>	NOAA <sub>170</sub>	NOAA <sub>171</sub>	NOAA <sub>172</sub>	NOAA <sub>173</sub>	NOAA <sub>174</sub>	NOAA <sub>175</sub>	NOAA <sub>176</sub>	NOAA <sub>177</sub>	NOAA <sub>178</sub>	NOAA <sub>179</sub>	NOAA <sub>180</sub>	NOAA <sub>181</sub>	NOAA <sub>182</sub>	NOAA <sub>183</sub>	NOAA <sub>184</sub>	NOAA <sub>185</sub>	NOAA <sub>186</sub>	NOAA <sub>187</sub>	NOAA <sub>188</sub>	NOAA <sub>189</sub>	NOAA <sub>190</sub>	NOAA <sub>191</sub>	NOAA <sub>192</sub>	NOAA <sub>193</sub>	NOAA <sub>194</sub>	NOAA <sub>195</sub>	NOAA <sub>196</sub>	NOAA <sub>197</sub>	NOAA <sub>198</sub>	NOAA <sub>199</sub>	NOAA <sub>200</sub>	NOAA <sub>201</sub>	NOAA <sub>202</sub>	NOAA <sub>203</sub>	NOAA <sub>204</sub>	NOAA <sub>205</sub>	NOAA <sub>206</sub>	NOAA <sub>207</sub>	NOAA <sub>208</sub>	NOAA <sub>209</sub>	NOAA <sub>210</sub>	NOAA <sub>211</sub>	NOAA <sub>212</sub>	NOAA <sub>213</sub>	NOAA <sub>214</sub>	NOAA <sub>215</sub>	NOAA <sub>216</sub>	NOAA <sub>217</sub>	NOAA <sub>218</sub>	NOAA <sub>219</sub>	NOAA <sub>220</sub>	NOAA <sub>221</sub>	NOAA <sub>222</sub>	NOAA <sub>223</sub>	NOAA <sub>224</sub>	NOAA <sub>225</sub>	NOAA <sub>226</sub>	NOAA <sub>227</sub>	NOAA <sub>228</sub>	NOAA <sub>229</sub>	NOAA <sub>230</sub>	NOAA <sub>231</sub>	NOAA <sub>232</sub>	NOAA <sub>233</sub>	NOAA <sub>234</sub>	NOAA <sub>235</sub>	NOAA <sub>236</sub>	NOAA <sub>237</sub>	NOAA <sub>238</sub>	NOAA <sub>239</sub>	NOAA <sub>240</sub>	NOAA <sub>241</sub>	NOAA <sub>242</sub>	NOAA <sub>243</sub>	NOAA <sub>244</sub>	NOAA <sub>245</sub>	NOAA <sub>246</sub>	NOAA <sub>247</sub>	NOAA <sub>248</sub>	NOAA <sub>249</sub>	NOAA <sub>250</sub>	NOAA <sub>251</sub>	NOAA <sub>252</sub>	NOAA <sub>253</sub>	NOAA <sub>254</sub>	NOAA <sub>255</sub>	NOAA <sub>256</sub>	NOAA <sub>257</sub>	NOAA <sub>258</sub>	NOAA <sub>259</sub>	NOAA <sub>260</sub>	NOAA <sub>261</sub>	NOAA <sub>262</sub>	NOAA <sub>263</sub>	NOAA <sub>264</sub>	NOAA <sub>265</sub>	NOAA <sub>266</sub>	NOAA <sub>267</sub>	NOAA <sub>268</sub>	NOAA <sub>269</sub>	NOAA <sub>270</sub>	NOAA <sub>271</sub>	NOAA <sub>272</sub>	NOAA <sub>273</sub>	NOAA <sub>274</sub>	NOAA <sub>275</sub>	NOAA <sub>276</sub>	NOAA <sub>277</sub>	NOAA <sub>278</sub>	NOAA <sub>279</sub>	NOAA <sub>280</sub>	NOAA <sub>281</sub>	NOAA <sub>282</sub>	NOAA <sub>283</sub>	NOAA <sub>284</sub>	NOAA <sub>285</sub>	NOAA <sub>286</sub>	NOAA <sub>287</sub>	NOAA <sub>288</sub>	NOAA <sub>289</sub>	NOAA <sub>290</sub>	NOAA <sub>291</sub>	NOAA <sub>292</sub>	NOAA <sub>293</sub>	NOAA <sub>294</sub>	NOAA <sub>295</sub>	NOAA <sub>296</sub>	NOAA <sub>297</sub>	NOAA <sub>298</sub>	NOAA <sub>299</sub>	NOAA <sub>300</sub>	NOAA <sub>301</sub>	NOAA <sub>302</sub>	NOAA <sub>303</sub>	NOAA <sub>304</sub>	NOAA <sub>305</sub>	NOAA <sub>306</sub>	NOAA <sub>307</sub>	NOAA <sub>308</sub>	NOAA <sub>309</sub>	NOAA <sub>310</sub>	NOAA <sub>311</sub>	NOAA <sub>312</sub>	NOAA <sub>313</sub>	NOAA <sub>314</sub>	NOAA <sub>315</sub>	NOAA <sub>316</sub>	NOAA <sub>317</sub>	NOAA <sub>318</sub>	NOAA <sub>319</sub>	NOAA <sub>320</sub>	NOAA <sub>321</sub>	NOAA <sub>322</sub>	NOAA <sub>323</sub>	NOAA <sub>324</sub>	NOAA <sub>325</sub>	NOAA <sub>326</sub>	NOAA <sub>327</sub>	NOAA <sub>328</sub>	NOAA <sub>329</sub>	NOAA <sub>330</sub>	NOAA <sub>331</sub>	NOAA <sub>332</sub>	NOAA <sub>333</sub>	NOAA <sub>334</sub>	NOAA <sub>335</sub>	NOAA <sub>336</sub>	NOAA <sub>337</sub>	NOAA <sub>338</sub>	NOAA <sub>339</sub>	NOAA <sub>340</sub>	NOAA <sub>341</sub>	NOAA <sub>342</sub>	NOAA <sub>343</sub>	NOAA <sub>344</sub>	NOAA <sub>345</sub>	NOAA <sub>346</sub>	NOAA <sub>347</sub>	NOAA <sub>348</sub>	NOAA <sub>349</sub>	NOAA <sub>350</sub>	NOAA <sub>351</sub>	NOAA <sub>352</sub>	NOAA <sub>353</sub>	NOAA <sub>354</sub>	NOAA <sub>355</sub>	NOAA <sub>356</sub>	NOAA <sub>357</sub>	NOAA <sub>358</sub>	NOAA <sub>359</sub>	NOAA <sub>360</sub>	NOAA <sub>361</sub>	NOAA <sub>362</sub>	NOAA <sub>363</sub>	NOAA <sub>364</sub>	NOAA <sub>365</sub>	NOAA <sub>366</sub>	NOAA <sub>367</sub>	NOAA <sub>368</sub>	NOAA <sub>369</sub>	NOAA <sub>370</sub>	NOAA <sub>371</sub>	NOAA <sub>372</sub>	NOAA <sub>373</sub>	NOAA <sub>374</sub>	NOAA <sub>375</sub>	NOAA <sub>376</sub>	NOAA <sub>377</sub>	NOAA <sub>378</sub>	NOAA <sub>379</sub>	NOAA <sub>380</sub>	NOAA <sub>381</sub>	NOAA <sub>382</sub>	NOAA <sub>383</sub>	NOAA <sub>384</sub>	NOAA <sub>385</sub>	NOAA <sub>386</sub>	NOAA <sub>387</sub>	NOAA <sub>388</sub>	NOAA <sub>389</sub>	NOAA <sub>390</sub>	NOAA <sub>391</sub>	NOAA <sub>392</sub>	NOAA <sub>393</sub>	NOAA <sub>394</sub>	NOAA <sub>395</sub>	NOAA <sub>396</sub>	NOAA <sub>397</sub>	NOAA <sub>398</sub>	NOAA <sub>399</sub>	NOAA <sub>400</sub>	NOAA <sub>401</sub>	NOAA <sub>402</sub>	NOAA <sub>403</sub>	NOAA <sub>404</sub>	NOAA <sub>405</sub>	NOAA <sub>406</sub>	NOAA <sub>407</sub>	NOAA <sub>408</sub>	NOAA <sub>409</sub>	NOAA <sub>410</sub>	NOAA <sub>411</sub>	NOAA <sub>412</sub>	NOAA <sub>413</sub>	NOAA <sub>414</sub>	NOAA <sub>415</sub>	NOAA <sub>416</sub>	NOAA <sub>417</sub>	NOAA <sub>418</sub>	NOAA <sub>419</sub>	NOAA <sub>420</sub>	NOAA <sub>421</sub>	NOAA <sub>422</sub>	NOAA <sub>423</sub>	NOAA <sub>424</sub>	NOAA <sub>425</sub>	NOAA <sub>426</sub>	NOAA <sub>427</sub>	NOAA <sub>428</sub>	NOAA <sub>429</sub>	NOAA <sub>430</sub>	NOAA <sub>431</sub>	NOAA <sub>432</sub>	NOAA <sub>433</sub>	NOAA <sub>434</sub>	NOAA <sub>435</sub>	NOAA <sub>436</sub>	NOAA <sub>437</sub>	NOAA <sub>438</sub>	NOAA <sub>439</sub>	NOAA <sub>440</sub>	NOAA <sub>441</sub>	NOAA <sub>442</sub>	NOAA <sub>443</sub>	NOAA <sub>444</sub>	NOAA <sub>445</sub>	NOAA <sub>446</sub>	NOAA <sub>447</sub>	NOAA <sub>448</sub>	NOAA <sub>449</sub>	NOAA <sub>450</sub>	NOAA <sub>451</sub>	NOAA <sub>452</sub>	NOAA <sub>453</sub>	NOAA <sub>454</sub>	NOAA <sub>455</sub>	NOAA <sub>456</sub>	NOAA <sub>457</sub>	NOAA <sub>458</sub>	NOAA <sub>459</sub>	NOAA <sub>460</sub>	NOAA <sub>461</sub>	NOAA <sub>462</sub>	NOAA <sub>463</sub>	NOAA <sub>464</sub>	NOAA <sub>465</sub>	NOAA <sub>466</sub>	NOAA <sub>467</sub>	NOAA <sub>468</sub>	NOAA <sub>469</sub>	NOAA <sub>470</sub>	NOAA <sub>471</sub>	NOAA <sub>472</sub>	NOAA <sub>473</sub>	NOAA <sub>474</sub>	NOAA <sub>475</sub>	NOAA <sub>476</sub>	NOAA <sub>477</sub>	NOAA <sub>478</sub>	NOAA <sub>479</sub>	NOAA <sub>480</sub>	NOAA <sub>481</sub>	NOAA <sub>482</sub>	NOAA <sub>483</sub>	NOAA <sub>484</sub>	NOAA <sub>485</sub>	NOAA <sub>486</sub>	NOAA <sub>487</sub>	NOAA <sub>488</sub>	NOAA <sub>489</sub>	NOAA <sub>490</sub>	NOAA <sub>491</sub>	NOAA <sub>492</sub>	NOAA <sub>493</sub>	NOAA <sub>494</sub>	NOAA <sub>495</sub>	NOAA <sub>496</sub>	NOAA <sub>497</sub>	NOAA <sub>498</sub>	NOAA <sub>499</sub>	NOAA <sub>500</sub>	NOAA <sub>501</sub>	NOAA <sub>502</sub>	NOAA <sub>503</sub>	NOAA <sub>504</sub>	NOAA <sub>505</sub>	NOAA <sub>506</sub>	NOAA <sub>507</sub>	NOAA <sub>508</sub>	NOAA <sub>509</sub>	NOAA <sub>510</sub>	NOAA <sub>511</sub>	NOAA <sub>512</sub>	NOAA <sub>513</sub>	NOAA <sub>514</sub>	NOAA <sub>515</sub>	NOAA <sub>516</sub>	NOAA <sub>517</sub>	NOAA <sub>518</sub>	NOAA <sub>519</sub>	NOAA <sub>520</sub>	NOAA <sub>521</sub>	NOAA <sub>522</sub>	NOAA <sub>523</sub>	NOAA <sub>524</sub>	NOAA <sub>525</sub>	NOAA <sub>526</sub>	NOAA <sub>527</sub>	NOAA <sub>528</sub>	NOAA <sub>529</sub>	NOAA <sub>530</sub>	NOAA <sub>531</sub>	NOAA <sub>532</sub>	NOAA <sub>533</sub>	NOAA <sub>534</sub>	NOAA <sub>535</sub>	NOAA <sub>536</sub>	NOAA <sub>537</sub>	NOAA <sub>538</sub>	NOAA <sub>539</sub>	NOAA <sub>540</sub>	NOAA 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<sub>591</sub>	NOAA <sub>592</sub>	NOAA <sub>593</sub>	NOAA <sub>594</sub>	NOAA <sub>595</sub>	NOAA <sub>596</sub>	NOAA <sub>597</sub>	NOAA <sub>598</sub>	NOAA <sub>599</sub>	NOAA <sub>600</sub>	NOAA <sub>601</sub>	NOAA <sub>602</sub>	NOAA <sub>603</sub>	NOAA <sub>604</sub>	NOAA <sub>605</sub>	NOAA <sub>606</sub>	NOAA <sub>607</sub>	NOAA <sub>608</sub>	NOAA <sub>609</sub>	NOAA <sub>610</sub>	NOAA <sub>611</sub>	NOAA <sub>612</sub>	NOAA <sub>613</sub>	NOAA <sub>614</sub>	NOAA <sub>615</sub>	NOAA <sub>616</sub>	NOAA <sub>617</sub>	NOAA <sub>618</sub>	NOAA <sub>619</sub>	NOAA <sub>620</sub>	NOAA <sub>621</sub>	NOAA <sub>622</sub>	NOAA <sub>623</sub>	NOAA <sub>624</sub>	NOAA <sub>625</sub>	NOAA <sub>626</sub>	NOAA <sub>627</sub>	NOAA <sub>628</sub>	NOAA <sub>629</sub>	NOAA <sub>630</sub>	NOAA <sub>631</sub>	NOAA <sub>632</sub>	NOAA <sub>633</sub>	NOAA <sub>634</sub>	NOAA <sub>635</sub>	NOAA <sub>636</sub>	NOAA <sub>637</sub>	NOAA <sub>638</sub>	NOAA <sub>639</sub>	NOAA <sub>640</sub>	NOAA <sub>641</sub>	NOAA <sub>642</sub>	NOAA <sub>643</sub>	NOAA <sub>644</sub>	NOAA <sub>645</sub>	NOAA <sub>646</sub>	NOAA <sub>647</sub>	NOAA <sub>648</sub>	NOAA <sub>649</sub>	NOAA <sub>650</sub>	NOAA <sub>651</sub>	NOAA <sub>652</sub>	NOAA <sub>653</sub>	NOAA <sub>654</sub>	NOAA <sub>655</sub>	NOAA <sub>656</sub>	NOAA <sub>657</sub>	NOAA <sub>658</sub>	NOAA <sub>659</sub>	NOAA <sub>660</sub>	NOAA <sub>661</sub>	NOAA <sub>662</sub>	NOAA <sub>663</sub>	NOAA <sub>664</sub>	NOAA <sub>665</sub>	NOAA <sub>666</sub>	NOAA <sub>667</sub>	NOAA <sub>668</sub>	NOAA <sub>669</sub>	NOAA <sub>670</sub>	NOAA <sub>671</sub>	NOAA <sub>672</sub>	NOAA <sub>673</sub>	NOAA <sub>674</sub>	NOAA <sub>675</sub>	NOAA <sub>676</sub>	NOAA <sub>677</sub>	NOAA <sub>678</sub>	NOAA <sub>679</sub>	NOAA <sub>680</sub>	NOAA <sub>681</sub>	NOAA <sub>682</sub>	NOAA <sub>683</sub>	NOAA <sub>684</sub>	NOAA <sub>685</sub>	NOAA <sub>686</sub>	NOAA <sub>687</sub>	NOAA <sub>688</sub>	NOAA <sub>689</sub>	NOAA <sub>690</sub>	NOAA <sub>691</sub>	NOAA <sub>692</sub>	NOAA <sub>693</sub>	NOAA <sub>694</sub>	NOAA <sub>695</sub>	NOAA <sub>696</sub>	NOAA <sub>697</sub>	NOAA <sub>698</sub>	NOAA <sub>699</sub>	NOAA <sub>700</sub>	NOAA <sub>701</sub>	NOAA <sub>702</sub>	NOAA <sub>703</sub>	NOAA <sub>704</sub>	NOAA <sub>705</sub>	NOAA<

# Forecasting:

# Forecasting: 1<sup>st</sup> Generation Model

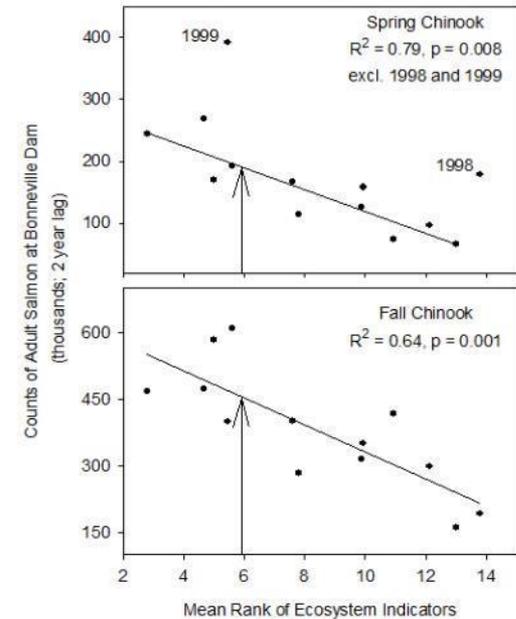
Indicators

Year

Ecosystem Indicators	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
PDO (December-March)	18	6	3	12	7	17	11	15	12	9	5	1	14	4	2	8	10
PDO (May-September)	10	4	6	5	11	15	14	16	12	13	2	9	7	3	1	8	12
ONI Jan-June	17	2	1	5	13	14	12	16	7	11	3	9	16	4	5	7	9
46050 SST (May-Sept)	16	8	3	4	1	7	17	14	5	16	2	9	6	10	11	12	13
NH 05 Upper 20 m T winter prior (Nov-Mar)	17	11	8	10	6	14	15	12	13	5	1	9	16	4	3	7	2
NH 05 Upper 20 m T (May-Sept)	13	10	12	4	1	3	17	15	7	8	2	5	11	9	6	14	16
NH 05 Deep Temperature (May-Sept)	17	6	8	4	1	9	12	14	10	5	2	7	13	11	3	16	15
NH 05 Deep Salinity (May-Sept)	17	3	7	4	5	13	14	8	6	1	2	11	15	10	9	12	10
Copepod Richness Anomaly	17	2	1	7	6	13	12	18	14	11	9	10	16	4	5	3	8
N. Copepod Biomass Anomaly	18	13	9	10	3	15	12	17	14	11	6	8	7	1	2	4	5
S. Copepod Biomass Anomaly	17	2	5	4	3	13	14	18	12	10	1	7	15	9	8	6	11
Biological Transition	17	11	6	7	8	12	10	18	15	3	1	2	14	4	9	5	13
Winter Ichthyoplankton	17	8	2	4	6	15	14	10	13	12	1	9	3	11	7	5	16
Chinook Juv Catches (June)	16	4	5	14	10	12	15	17	11	8	1	6	7	13	3	2	9
Coho Juv Catches (June)	16	7	11	5	6	2	12	17	14	3	4	8	9	12	16	1	10
Mean of Ranks	15.9	6.5	5.8	6.6	5.8	11.6	13.5	14.5	11.1	8.4	2.8	7.3	11.2	7.3	5.9	7.3	11.3

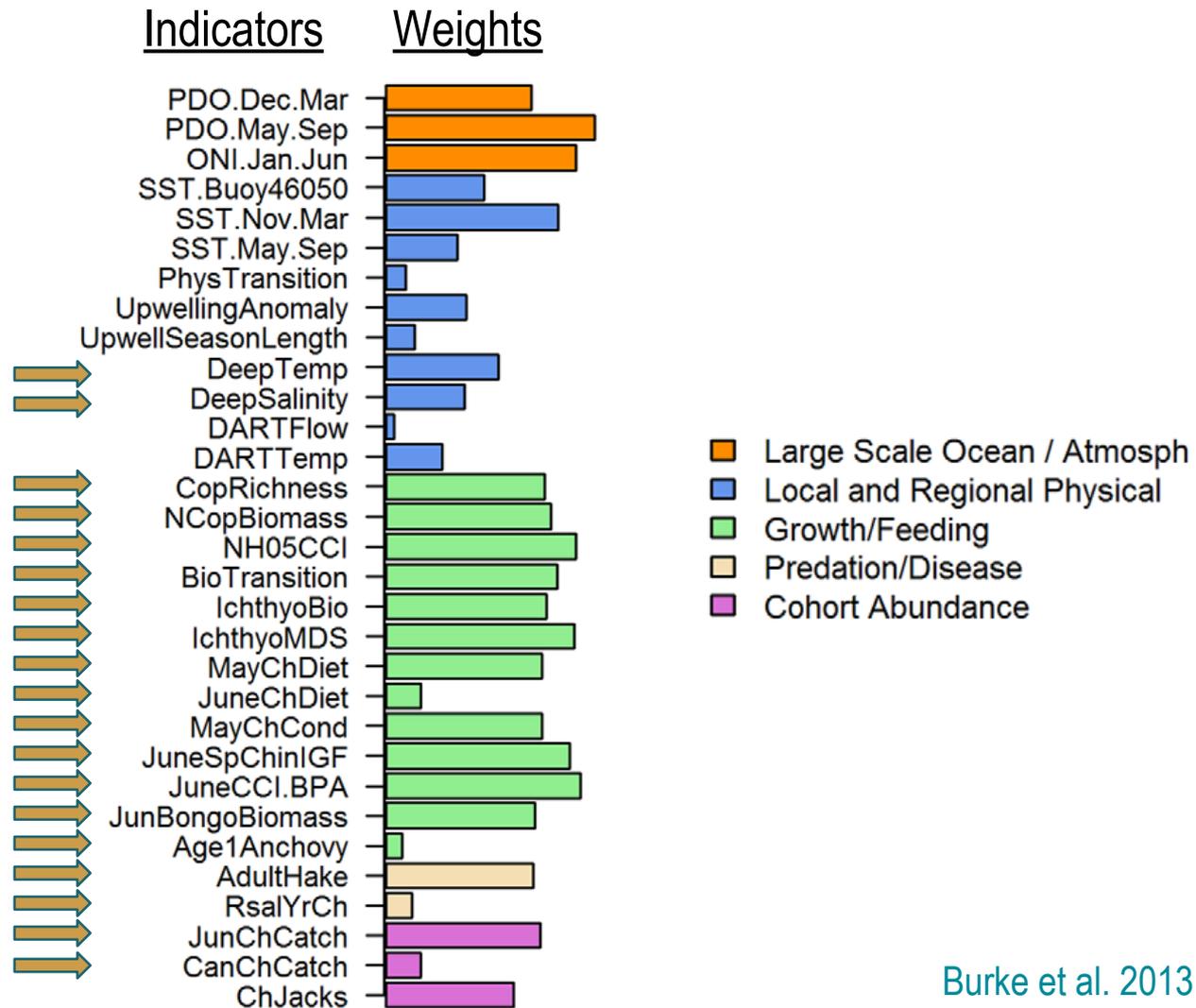
Good Fair Poor

Forecasted Returns in 2013



<http://www.nwfsc.noaa.gov/oceanconditions>

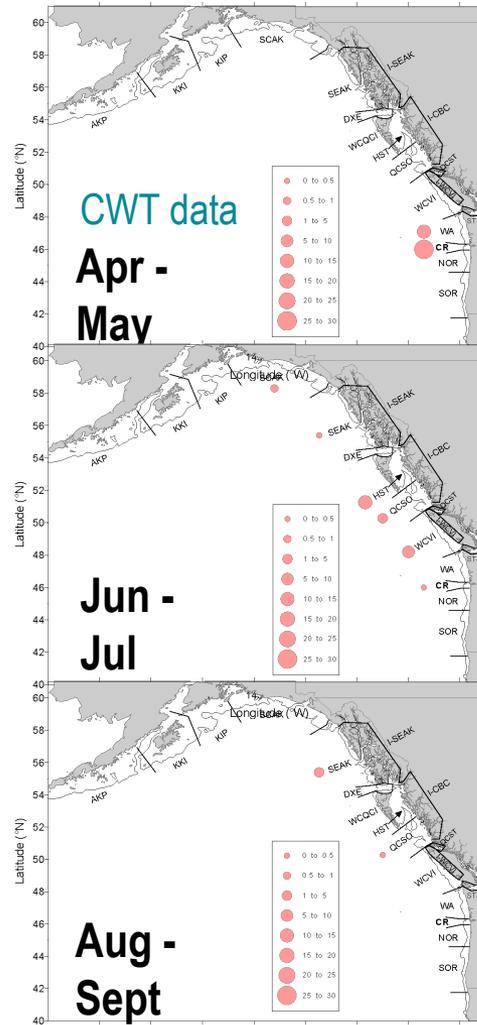
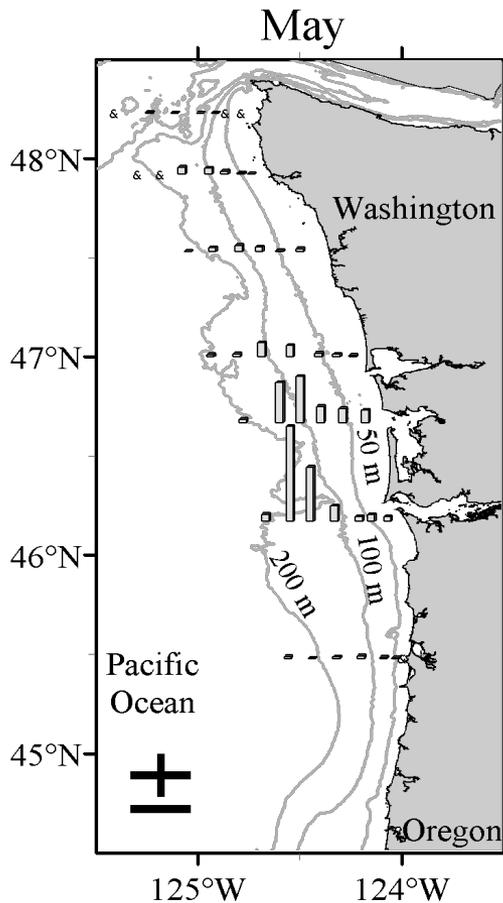
# Forecasting: 2<sup>nd</sup> Generation Model



Burke et al. 2013 *PLoS ONE*

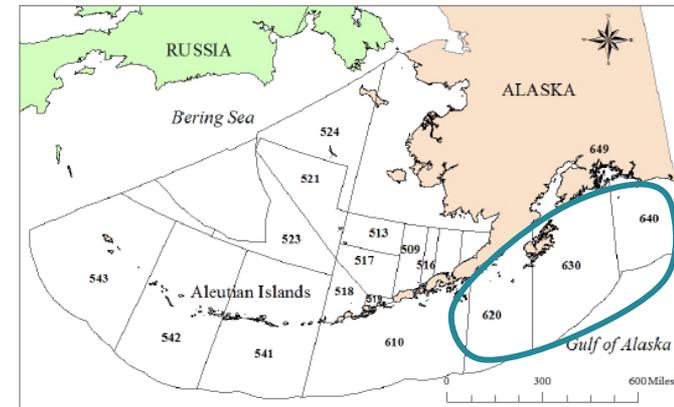
# Spatial Distribution

Snake River yearling Chinook salmon



Adapted from Fisher et al. 2014, TAFS

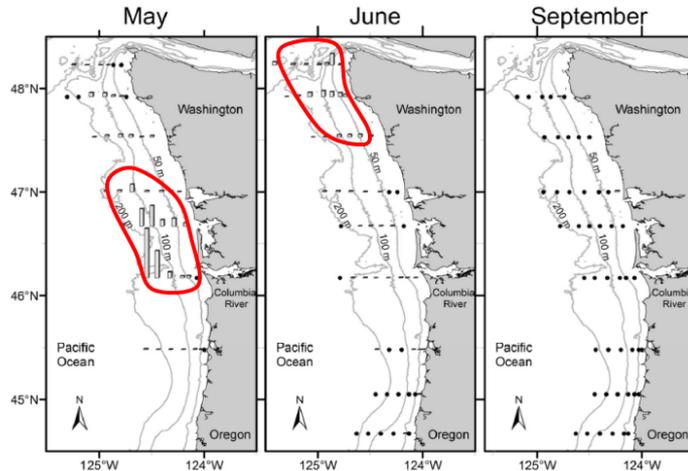
- 60-80% of juvenile Chinook salmon caught in AFSC surveys were from Oregon, Washington, and Columbia River
- 40% of Chinook from walleye pollock bycatch was from U.S. West Coast



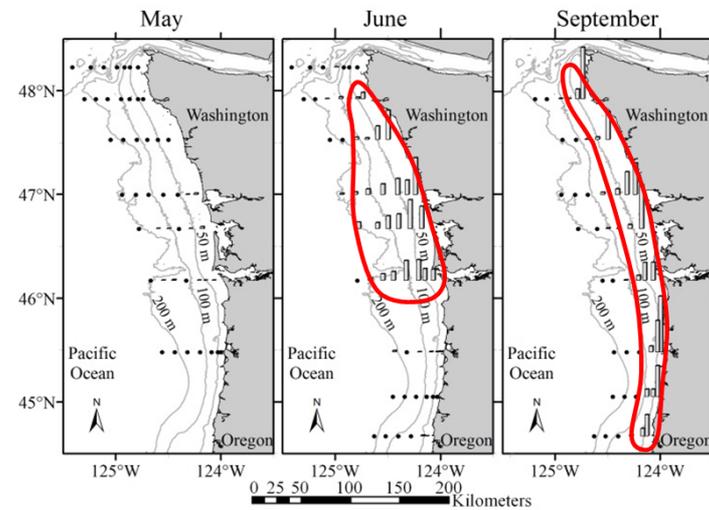
Guyon et al. 2015. NOAA Tech Memo NMFS-AFSC-291

# Spatial distribution is stock-specific

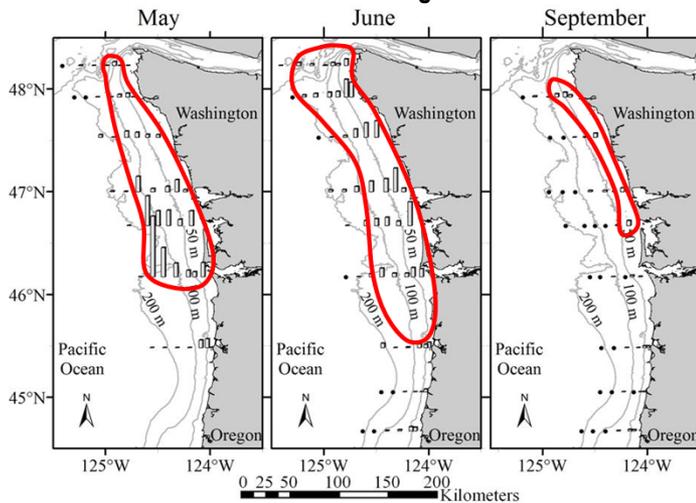
Snake River Yearling Spring Chinook



Snake River Subyearling Fall Chinook



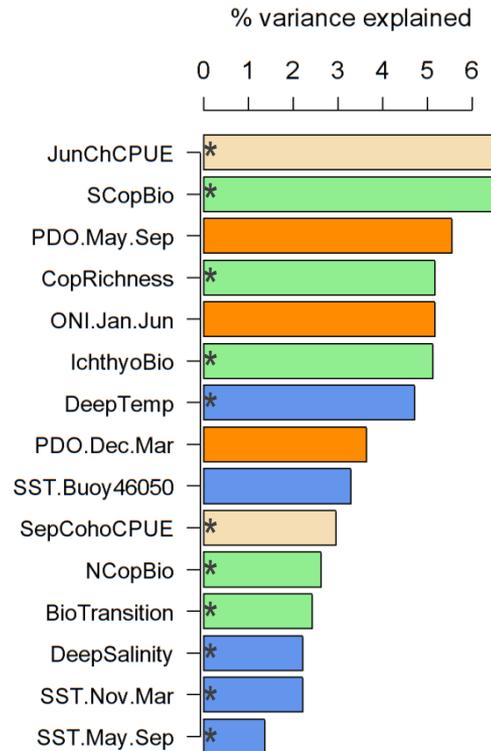
Snake River Yearling Fall Chinook



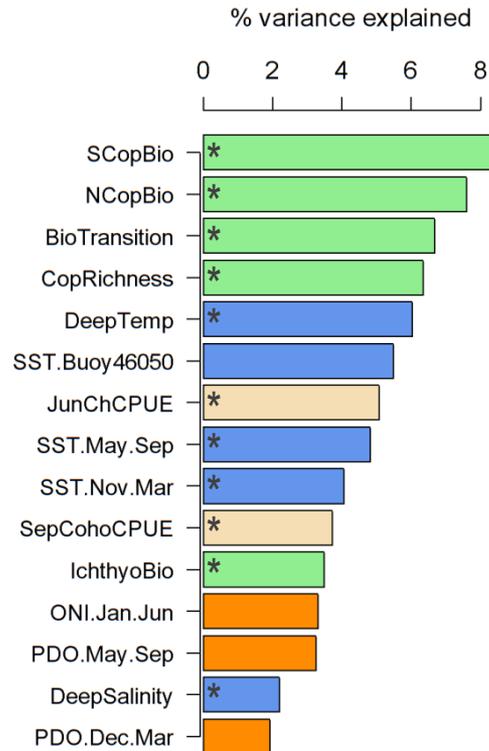
Teel et al. 2015. Marine and Coastal Fisheries, In press.

# Variable importance differs among runs/species

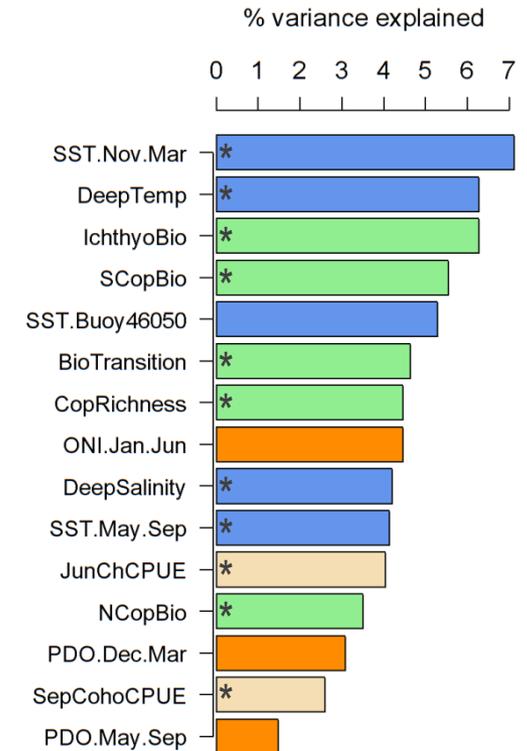
## Spring Chinook



## Fall Chinook



## Coho

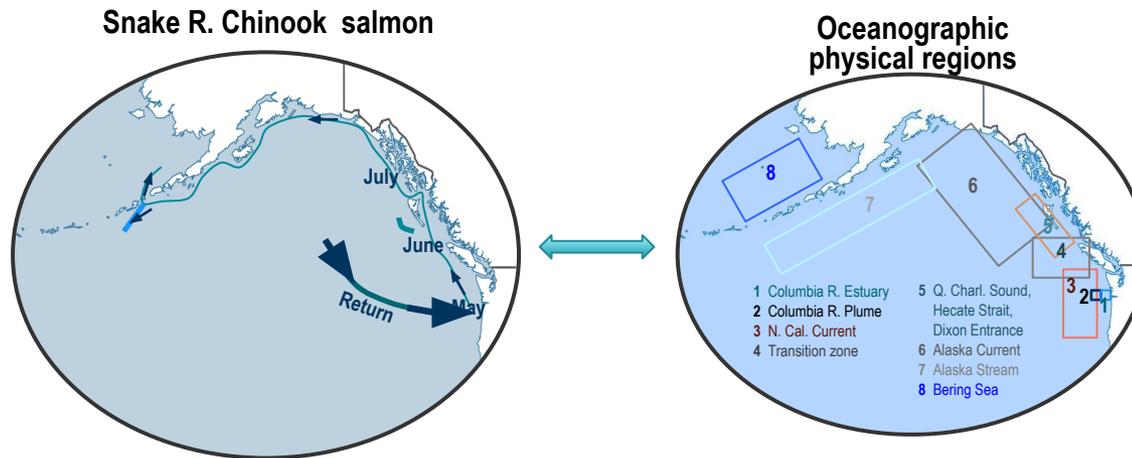


- Large Scale Ocean / Atmosph
- Local and Regional Physical
- Growth/Feeding
- Cohort Abundance

\* Collected during NWFSC cruises

# Forecasting: 3<sup>rd</sup> Generation Model

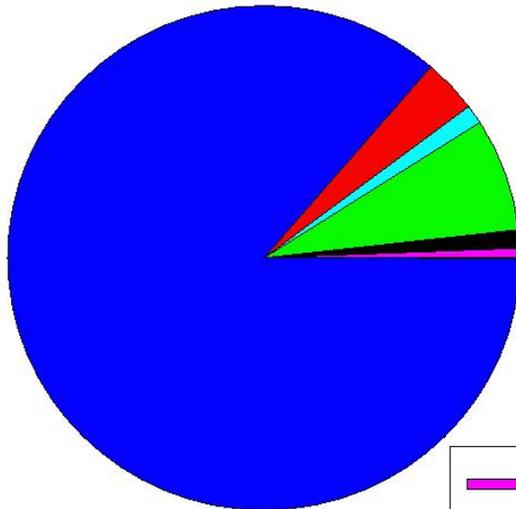
- Better tools
  - Multivariate Autoregressive State Space Models
  - Spatial Factor Analysis
- Better spatial/temporal matchup



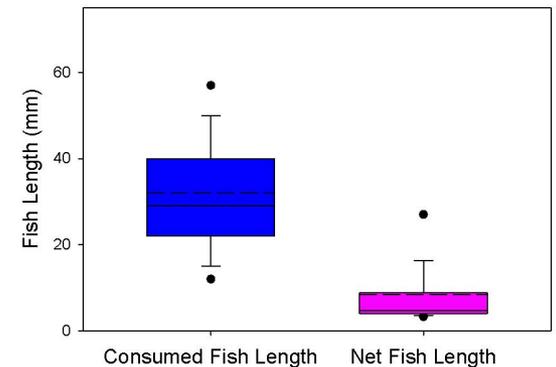
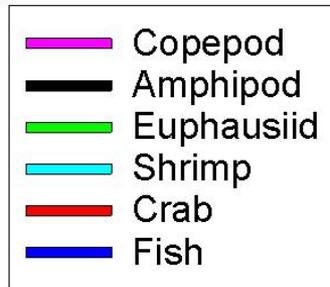
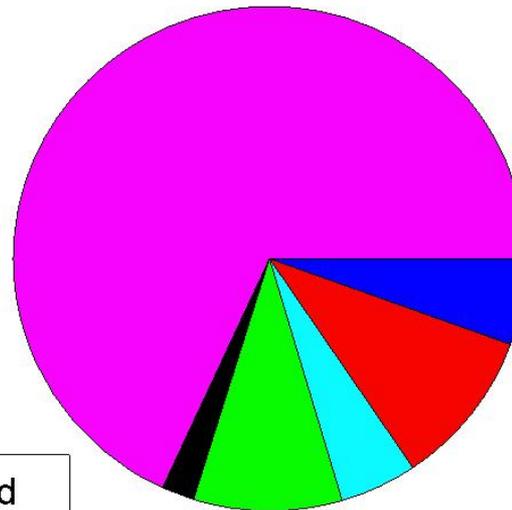
# Data Gaps:

# Data Gaps: We don't sample their prey

Chinook Salmon  
Diet Composition by Biomass



Bongo Net Composition by Biomass



# Data Gaps: We don't sample their predators



Back-of-the-envelope estimates suggest >5 million smolts/year

Sooty Shearwaters and Common Murres; photograph: Jen Zamon