Results from the coastal and fjord salmon fishery in 2012 in Nordland, Troms and Finnmark: timing of the salmon catches, wild and escaped salmon, sea- and freshwater ages, sex distributions and other biological parameters

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Abstract

Migratory pattern with the ecology of salmon was studied in the last phase of the marine life for wild and escaped salmon in Northern Norway within Kolarctic salmon ENPI EU KO197 project. Huge coastal area in Northern Norway from Lofoten in Nordland County over Troms County to the easternmost Finnmark County in the border area between Norway and Russia was covered by 53 professional salmon fishermen fishing salmon from early May to early September. Special attention was put to select fishermen on the areas where catches are the highest and catch data is representative. These fishermen collected information from each individual salmon in their catches and they took scale samples from salmon for genetic, age- and growth analysis and for wild salmon or escaped salmon detection. Scales from salmon are used for genetic analyzes when genotyping the river of origin for all wild salmon. Based on the timing of 11200 salmon belonging to 1SW (one sea-winter) 2SW, 3SW, 4SW, previous spawners and escaped salmon in the catches one can determine the time of the migration periods for salmon in outermost coastal areas as well as in fjords. In this study in the year 2012 we covered the entire migration period of salmon from the beginning of May to the end of August-early September, which period has been historically the main migration as well as fishing time of salmon. Professional fishermen served their help to obtain all the material collected from salmon with ordinary fishing methods like bag nets and bend nets. There are some hundreds of salmon rivers in this Kolarctic salmon project area (Nordland, Troms, Finnmark in Norway; tributaries for the River Tana and upper areas of the River Neiden in Finland; Kola, Archangelsk, Karelia, Komi in Russia) with their genetically different stocks. Therefore the sampling of salmon was decided to cover spatially and temporally from May to September to cover the migration periods of all the stocks although it is recognized that most of the stocks are migrating simultaneously within the narrow time frame.
Introduction

See the introduction in Report I. Report II is demonstrating the results from the coastal fishery in 2012.

Material and methods

Figure 1. Sites (red points) in the salmon fishing at sea in Kolarctic area in Northern Norway in the year 2012. Sites are indicating the locations where sampling from the salmon catches took place from May to September. In Kolarctic area there were 53 salmon fishermen in 2012 who took samples from their catches; in Nordland 5, in Troms 10 and in Finnmark 37 fishermen, respectively.

In the Kolarctic salmon project we are studying the migratory pattern of salmon in the coastal and fjord areas of Northern Norway where the captured salmon have origin from hundreds of rivers. Migratory pattern includes to clarify the timing of wild 1SW (one-sea-winter salmon), 2SW, 3SW, 4SW salmon and previous spawned salmon in the catches as well as the timing of the escaped salmon in the catches. The aim was to have continuous sampling covering the entire period during that time when salmon is migrating along the coastal areas from early May to late September. To fulfill the goal of the Kolarctic salmon project and to have good documentation from the timing of different stocks in different areas and in different fisheries all the fishermen serving this project received special permission to catch salmon outside the official fishing season. Within this project in Nordland and in Troms counties fishermen had also possibility to use bend nets in addition or instead of using bag nets which are the only allowed fishing method today.
there. Especial attention was put to include fishermen from the outermost coastal areas, where the catch informs more precisely the timing of the migrations in general and especially for different stocks than the catches in fjords (Figure 1).

All the fishermen were advised to take careful measurements from all their salmon catches like lengths and weights and it was especially highlighted to take the scale samples from the recommended area of the fish. Fishermen had to write information in the scale bags which were designed especially for this Kolarctic project. Scales were collected from the advised area of the fish to be sure on the correct ageing and growth measurements analyzed and measured from the scales. Fishermen recognized also the origin (wild/escaped) of the salmon using external and internal features of salmon and in this work the manual with photos from wild and escaped salmon helped the recognition. The date of the capture, fishing method and sex of fish and numbers of salmon lice was also recorded into the scale bag. Fishermen sent the scale bags in envelopes in two weeks periods to County Governor in Finnmark or scales were collected in Finnmark when frequently visiting them.

The data written into the scale bags was transferred into data file and the first evaluation of the accuracy of the data took place by correcting the false or some lacking information. All scale bags had a new numbering corresponding to the number in the data file. At this phase also 5 scales were picked into a new numbered scale bag and they (only wild salmon) were sent for genetic analysis to the University of Turku. Scale impressions for age determination, growth measurements and for analyzing the origin of salmon (wild/escaped) were done from all c. 11 200 scales. Almost all the scales in scale envelopes from all individual salmon had impressed figures in the plastic plates. After the scale impressions were available, ageing and discrimination between wild and escaped salmon took place. Work was done following the ICES scale reading working group’s (2011) recommendations. Last work was the internal evaluation and correction of the basic scale data where we compared the ages of salmon to the informed lengths and weights.

Out of 53 fishermen who promised to have the sampling over the whole season 9 ceased the sampling in June or early in July (Figure 3). The numbers of salmon caught in May to September were in Nordland, Troms and Finnmark 754 (7%), 3183 (28%) and 7283 (65%), respectively (Table I).
Figure 2. Dates when salmon catch occurred in the fishery between May and October. The numbers of fishermen (y-axis) from the number 73 to the number 1 are from west (blue = Nordland), middle (red = Troms) to east (green = Finnmark). Salmon fishing started with a special permission in the beginning of May instead of the ordinary start in the beginning of June in Finnmark or in the middle of July in Troms and Nordland.
Table I. Numbers of samples from the coastal and fjord salmon fishery in Kolarctic project in 2012 by county, by month and by salmon sea-age for 1SW (one-sea-winter), 2SW, 3SW, 4SW, previous spawner and escaped salmon. In parentheses the values are indicating the monthly percentage distribution for each sea-ages. In the total column there are the numbers for each sea-age group of salmon and the percentages are indicating the proportion of each sea-age group in the total number of salmon caught in each county during the whole fishing time.

<table>
<thead>
<tr>
<th>Sea-age</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>Total, total-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1SW salmon</td>
<td>3, (2)</td>
<td>80, (46)</td>
<td>49, (30)</td>
<td>35, (22)</td>
<td>167, (22)</td>
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<td></td>
</tr>
<tr>
<td>2SW salmon</td>
<td>55, (15)</td>
<td>216, (61)</td>
<td>57, (16)</td>
<td>27, (8)</td>
<td>355, (47)</td>
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<td></td>
</tr>
<tr>
<td>3SW salmon</td>
<td>6, (16)</td>
<td>23, (50)</td>
<td>10, (23)</td>
<td>5, (11)</td>
<td>44, (6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4SW salmon</td>
<td>1</td>
<td>71</td>
<td>73</td>
<td>1281</td>
<td>2</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Previous spawning salmon</td>
<td>7, (31)</td>
<td>11, (48)</td>
<td>1, (4)</td>
<td>4, (17)</td>
<td>23, (3)</td>
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<tr>
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<td>9, (90)</td>
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<td>10, (1)</td>
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</tr>
<tr>
<td>Escaped salmon</td>
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<td>53, (35)</td>
<td>31, (20)</td>
<td>54, (36)</td>
<td>152, (20)</td>
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<td>Missing data from ages</td>
<td>1</td>
<td>1</td>
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<td></td>
<td>2, (&lt;1)</td>
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<td></td>
</tr>
<tr>
<td>Total salmon</td>
<td>87, (12)</td>
<td>393, (52)</td>
<td>148, (20)</td>
<td>126, (16)</td>
<td>754</td>
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<tr>
<td>Trout</td>
<td>3</td>
<td>1</td>
<td>5</td>
<td>9</td>
<td></td>
<td></td>
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<tr>
<td>Troms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1SW salmon</td>
<td>278, (23)</td>
<td>682, (57)</td>
<td>228, (19)</td>
<td>9, (1)</td>
<td>1197, (38)</td>
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</tr>
<tr>
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<td>25, (3)</td>
<td>539, (54)</td>
<td>334, (34)</td>
<td>86, (8)</td>
<td>989, (31)</td>
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<tr>
<td>3SW salmon</td>
<td>5, (1)</td>
<td>252, (59)</td>
<td>141, (33)</td>
<td>33, (7)</td>
<td>431, (14)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4SW salmon</td>
<td>14, (58)</td>
<td>9, (38)</td>
<td>1, (4)</td>
<td>24, (&lt;1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Previous spawning salmon</td>
<td>3, (4)</td>
<td>62, (79)</td>
<td>9, (12)</td>
<td>4, (5)</td>
<td>78, (2)</td>
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<td></td>
</tr>
<tr>
<td>Kelt</td>
<td>4, (10)</td>
<td>16, (41)</td>
<td>12, (31)</td>
<td>7, (18)</td>
<td>39, (1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Escaped salmon</td>
<td>8, (2)</td>
<td>82, (21)</td>
<td>175, (44)</td>
<td>128, (31)</td>
<td>3, (1)</td>
<td>398, (13)</td>
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<tr>
<td>Total salmon</td>
<td>43, (&lt;1)</td>
<td>1254, (39)</td>
<td>1370, (43)</td>
<td>490, (15)</td>
<td>16, (1)</td>
<td>3, (&lt;1)</td>
<td>3183</td>
</tr>
<tr>
<td>Trout</td>
<td>5</td>
<td>25</td>
<td>12</td>
<td>4</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finnmark</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1SW salmon</td>
<td>6, (&lt;1)</td>
<td>560, (18)</td>
<td>1866, (62)</td>
<td>568, (19)</td>
<td>22, (1)</td>
<td>3022, (41)</td>
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</tr>
<tr>
<td>2SW salmon</td>
<td>149, (6)</td>
<td>1302, (53)</td>
<td>774, (22)</td>
<td>210, (9)</td>
<td>7, (&lt;1)</td>
<td>2722, (34)</td>
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</tr>
<tr>
<td>3SW salmon</td>
<td>78, (9)</td>
<td>404, (48)</td>
<td>265, (32)</td>
<td>89, (10)</td>
<td>5, (1)</td>
<td>841, (12)</td>
<td></td>
</tr>
<tr>
<td>4SW salmon</td>
<td>3, (6)</td>
<td>40, (56)</td>
<td>20, (28)</td>
<td>7, (10)</td>
<td>70, (1)</td>
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<td></td>
</tr>
<tr>
<td>Previous spawning salmon</td>
<td>30, (18)</td>
<td>99, (59)</td>
<td>30, (18)</td>
<td>9, (5)</td>
<td>168, (12)</td>
<td></td>
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</tr>
<tr>
<td>Kelt</td>
<td>3, (3)</td>
<td>32, (32)</td>
<td>44, (44)</td>
<td>18, (18)</td>
<td>97, (1)</td>
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</tr>
<tr>
<td>Escaped salmon</td>
<td>27, (5)</td>
<td>131, (23)</td>
<td>189, (34)</td>
<td>215, (38)</td>
<td>2, (&lt;1)</td>
<td>564, (8)</td>
<td></td>
</tr>
<tr>
<td>Total salmon</td>
<td>297, (4)</td>
<td>2603, (36)</td>
<td>3211, (44)</td>
<td>1134, (16)</td>
<td>36, (&lt;1)</td>
<td>7283</td>
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</tr>
<tr>
<td>Trout</td>
<td>5</td>
<td>26</td>
<td>23</td>
<td>18</td>
<td>79, (1)</td>
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</tr>
<tr>
<td>Pacific salmon</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
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</table>

Table II. Weight in kilos from the coastal and fjord salmon fishery in Kolarctic project in 2012 by county, by month and by salmon sea-age for 1SW (one-sea-winter), 2SW, 3SW, 4SW, previous spawner and escaped salmon. In parentheses the values are indicating the monthly percentage distribution for each sea-ages.

<table>
<thead>
<tr>
<th>Sea-age</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>Total, total-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nordland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1SW salmon</td>
<td>6</td>
<td>182</td>
<td>120</td>
<td>84</td>
<td>392</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2SW salmon</td>
<td>169</td>
<td>765</td>
<td>196</td>
<td>94</td>
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<tr>
<td>3SW salmon</td>
<td>40</td>
<td>169</td>
<td>83</td>
<td>41</td>
<td>333</td>
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<td></td>
</tr>
<tr>
<td>4SW salmon</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
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<td>Previous spawning salmon</td>
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<td>54</td>
<td>4</td>
<td>22</td>
<td>111</td>
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<td></td>
</tr>
<tr>
<td>Kelt</td>
<td>4</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td>22</td>
<td></td>
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<tr>
<td>Escaped salmon</td>
<td>68</td>
<td>276</td>
<td>141</td>
<td>244</td>
<td>730</td>
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<tr>
<td>Total salmon</td>
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<td>1448</td>
<td>544</td>
<td>490</td>
<td>2809</td>
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<td>2</td>
<td>16</td>
<td>28</td>
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<td>Troms</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>1SW salmon</td>
<td>616</td>
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<td>600</td>
<td>19</td>
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<tr>
<td>2SW salmon</td>
<td>81</td>
<td>2231</td>
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<tr>
<td>3SW salmon</td>
<td>45</td>
<td>2057</td>
<td>1164</td>
<td>257</td>
<td>3523</td>
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<tr>
<td>4SW salmon</td>
<td>78</td>
<td>194</td>
<td>111</td>
<td>10</td>
<td>315</td>
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<td></td>
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<tr>
<td>Previous spawning salmon</td>
<td>20</td>
<td>531</td>
<td>78</td>
<td>27</td>
<td>657</td>
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<tr>
<td>Kelt</td>
<td>22</td>
<td>89</td>
<td>46</td>
<td>31</td>
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<tr>
<td>Escaped salmon</td>
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<td>654</td>
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<td>5577</td>
<td>1980</td>
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<td>Finnmark</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>1SW salmon</td>
<td>17</td>
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<td>4330</td>
<td>1281</td>
<td>49</td>
<td>6984</td>
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<tr>
<td>2SW salmon</td>
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<td>5694</td>
<td>3364</td>
<td>861</td>
<td>33</td>
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<tr>
<td>3SW salmon</td>
<td>653</td>
<td>3534</td>
<td>2256</td>
<td>661</td>
<td>42</td>
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<tr>
<td>4SW salmon</td>
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<td>510</td>
<td>247</td>
<td>88</td>
<td>832</td>
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<tr>
<td>Previous spawning salmon</td>
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<td>761</td>
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<td>73</td>
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<tr>
<td>Kelt</td>
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<td>170</td>
<td>153</td>
<td>67</td>
<td>404</td>
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<tr>
<td>Escaped salmon</td>
<td>151</td>
<td>796</td>
<td>923</td>
<td>1004</td>
<td>7</td>
<td>2882</td>
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<tr>
<td>Total salmon</td>
<td>1755</td>
<td>12897</td>
<td>11595</td>
<td>4106</td>
<td>131</td>
<td>30489</td>
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<td>12</td>
<td>12</td>
<td>26</td>
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</tr>
<tr>
<td>Pacific salmon</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
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</table>
Salmon catches can be seen as the total numbers of salmon (Figure 3) caught by each fishermen but to understand the huge diversity in the catches between areas and during the migration period it is best to analyze the material divided by sea-age groups (Figures 4 and 5).

**Figure 3.** The numbers of Atlantic salmon scale samples for each fisherman from Nordland (from the left) to Finnmark (to the right).

**Figure 4.** Numbers of salmon in the fishery and sea-age distributions and origin (wild/escaped) of salmon catches from the numbers of fish caught in Kolarctic area in Norway from May to September. The numbers of fishermen are from the Middle of Nordland (from the left) to Eastern Finnmark (to the right). See also the figure 1.
Figure 5. Sea-age distributions in terms of mass of salmon during the whole fishing period from May to October. Fishermen are from Nordland (from the left) to Finnmark (to the right).

Most of the fishermen made good work taking careful samples from all their catches. Figures 4 and 5 are illustrating the sea-age distributions of salmon caught by each fisherman in term of numbers and in terms on weight. Some fishermen didn’t have smallest salmon at all or only small amounts in their fishery because they ceased the fishery early in the season or they had large sized meshes in their bend nets which are selecting mainly large fishes of 2-3SW. Previous spawned salmon occurred in the catches in the entire Kolarctic area in the outermost coastal areas and in fjords. Figure 4 clearly indicates that the proportion of escaped salmon in the catches was decreasing steadily towards east in Northern Norway. In easternmost areas of Varangerfjord the occurrence of escaped salmon was low resulting partly from lower fishing activity late in the prolonged season compared to other areas.

Sea-age distributions in the salmon catches between fishermen are indicating differences in the mesh sizes in bend nets and in some areas fishery was targeting more or less only to multi-sea-winter salmon or mainly to small salmon. Figure 5 illustrates clearly the importance of large salmon (MSW salmon, multi-sea-winter salmon) for the fishery making large proportion of the catches measured in weight. These figures 4 and 5 are indicating the catch composition during the entire salmon migration period, not the catch composition during the legal fishing time in each county. Small 1SW salmon made for many fishermen large proportion in the catches in numbers but MSW salmon, however, made the highest values for them in economical aspects. 3SW salmon made quite small proportions in numbers in general in 2012 but in weight it was remarkable. Also the catch of escaped salmon in weight highlights its very high proportion in the fishery.
Results and discussion

1. May and June are important period for the migrations for large salmon and July for small salmon

Figure 6. Numbers and percentages of salmon caught during their migration period in the Kolarctic research in three northern counties in Norway in the year 2012. Note differences in y-axis between counties and sea-ages.

Figure 6. Numbers and percentages of salmon caught during their migration period in the Kolarctic research in three northern counties in Norway in the year 2012. Note differences in y-axis between counties and sea-ages.
Wild Atlantic salmon as well as escaped salmon is available to be caught at sea in the coast and fjord areas mainly from May to the end of September in Northern Norway (Nordland, Troms, Finnmark). Figure 6 gives an overview from the distributions of the catches in terms of numbers of salmon between the summer months in Kolarctic area. Figure 6 gives also an answer to one of the Kolarctic–project’s activities indicating the general migratory pattern. 1SW salmon made 21% in the total salmon catches in Nordland compared to 38% and 41% in Troms and Finnmark, respectively (Table I). Reason to the low abundance and therefore to the low percentage of 1SW salmon in Nordland catches can be that the sampling was not spatially and temporally representative in the coast areas and therefore not to be comparable with the data from other counties. SSB (Statistics Norway/ Statistisk sentralbyrå) salmon catch data, however, from Nordland indicates that salmon smaller than 3 kilos made in 2012 c. 35% but the official fishing time was only two weeks compared to Kolarctic project sampling period from May to September. In Troms and Finnmark, however, there were also some localities with low abundance and percentage of 1SW salmon (Figures 4 and 5). Two sea winter salmon made in Troms and Finnmark 31% and 34%, respectively, from the total numbers of salmon but in Nordland its share was as high as 49% (Table I). The percentage of previous spawners was quite low, 3-4%, in all counties. Escaped salmon made declining percentage with the increasing latitude in Kolarctic area being 20%, 13% and 8% from Nordland over to Finnmark.

Photo 1. Fisherman Kåre Jerijærvi in Sør-Varanger, Revøysund, with a c. 21 kg male wild salmon
Figure 7. The numbers of salmon in the catches in each summer month in Kolarctic counties in the year 2012. Note differences in y-axis between counties and sea-ages.
The monthly timing of the salmon catches was more or less the same between Troms and Finnmark counties (Figure 7). That was true for wild salmon. Numbers of escaped salmon increased towards autumn in Finnmark but they peaked in July in Troms. Material from Nordland County indicated that the highest numbers of 1SW, 2SW, 3SW and previous spawners occurred in June in the catches. From 1SW salmon catches it was taken in July in Troms and Finnmark 57% and 62%, respectively, but 2SW salmon was caught earlier, in May-June, with 57% and 59%. In May 2SW catch had higher proportion in Finnmark (6%) than in Troms (3%) and the highest proportion was in Nordland (15%) (Table I). From the large salmon, 3SW fish, catches almost 60% was taken in May-June in Finnmark and Troms and almost 70% in Nordland. The catch of previous spawners distributed also over the whole summer but the catch in June with c. 50-70% in Nordland, Troms and Finnmark was remarkable compared to the catch in May with c. 5-25%. Catches of escaped salmon increased steadily from May to August in the whole Kolarctic area. Especially in Finnmark the numbers of escaped salmon increased steadily towards autumn. Escaped salmon occurred in Nordland in high numbers in June as well as in August. The most important reason to the dramatic declining of escaped salmon catches after August is certainly the much lower interest of fishermen in this project to continue their fishing after the ordinary season when there is usually much lesser number of wild salmon available for fishery than earlier in the summer. Fishermen get also tired after fishing salmon actively over three months (May, June, July) and the fishing effort was much less in autumn than in the summer.

2. Overall migratory pattern for wild and escaped salmon at sea in Northern Norway in 2012

As soon as fishermen started to fish in the beginning of May only few of them caught some few salmon (Figure 8). It was expected, however, to have much better catches in early May in general at least in Finnmark based on the old historical information. Also based on the experiences of some of the oldest salmon fishermen it was expected to catch salmon belonging to the largest size group, larger than 7 kg fish. Unfortunately, weather conditions in most of the outermost coastal areas did not favor practical fishery and strong winds eliminated totally in some areas the use of bend nets.

In the Kolarctic area in the catch of female salmon, 2SW and 3SW fishes dominated the catches almost the whole “official” fishing season in June and July. 1SW fish entered to the coastal fishery during the week 21 especially in males and dominated in the male salmon catches from the week 25 to the week 34. Escaped salmon made almost throughout the entire official fishing season c. 10-15% from the weekly catches (female and male salmon catches combined) but their proportions started to increase clearly in the week 31 being 25% and that means each forth salmon in the catches to be escaped salmon, which is high amount. In August, when most of wild salmon has entered into their own rivers the proportions of escaped salmon in the catches made extremely high proportion exceeding almost 30% in the week 33.
Salmon catches expressed as weights (Figure 8) in each sea ages gives more informative picture on the economic value of medium and large sized salmon compared if expressing the data with numbers of salmon in each age groups. The catch in term of numbers is used especially when calculating the spatial and temporal exploitation of salmon between fishing methods, between the fisheries at sea and in the rivers etc. In Kolarctic area the catches were composed mainly of large salmon (2SW and older) to the end of the week 26, that is to the end of June. In whole July the mass of 1SW salmon made in average c. 30% of the total catch. Interesting is that in the end of July escaped salmon made as much as 15% from the total catches and its proportion increased to 35% to the end of the week 33 (Figure 8). In female salmon catches 1SW salmon had only very minor importance reaching c. 15% in the week 28. Previous spawning salmon made quite stable proportion in the total catches throughout the whole official fishing season being <10%, but making even 15% in some weeks in male salmon catches.

In the Kolarctic project fishermen tried to start the fishery as early as possible in the beginning of May to collect data from salmon for the migratory pattern analysis of all the sea age groups and especially to analyze the rivers of origin for all salmon caught in the coast and fjord areas. From the figure 9 it can be observed that in the whole Kolarctic area, combining the data from Nordland, Troms and Finnmark, female previous spawners ascended earlier than 2 and 3-4SW salmon and 2-4SW salmon were caught evenly throughout the entire summer. In males also the age groups of 3-4SW and previous spawners ascended earliest into the fishery but 2SW salmon came clearly later. Although escaped salmon occurred in the catches throughout the entire summer time their cumulative catches took place later but, however, a little
earlier than that for 1SW salmon in the beginning of the fishing season. Figure 9 indicates the general migratory pattern for wild 1-4SW salmon, previous spawners and escaped salmon.

Figure 9. Cumulative percentages of the catches in terms of numbers for wild 1-4SW salmon, previous spawners and escaped salmon in Kolarctic area between May to August 4.

Figure 10. Median dates with 25% and 75% interquartile range of the catches in terms of numbers for wild 1-4SW salmon, previous spawners and escaped salmon in Kolarctic area between May to August 4. Median date is the date within the main migratory period when 50% from the catch has been accumulated and 25%
interquartile date point is the date in the summer when 25% from the salmon were accumulated in the catches and respectively 75% corresponds the date when 75% from the salmon catches were accumulated.

Median date of capture with the interquartile range of 25% and 75% is one clear statistical parameter to indicate differences in the timing of migrations especially in such cases when the fishery is covering almost the entire migratory period stretching from early May to the begin of August. Figure 10 demonstrates clear differences in the median dates of the capture within the entire Kolarctic area in Norway between all sea-age groups for wild salmon and escaped salmon. In females the earliest median dates were for previous spawners around June 10 followed by 2SW and 3-4SW salmon and for 1SW salmon and escaped salmon early July. Here we must remember that migrations for escaped salmon are clearly continuing after August 4, which date is the end of the official fishing time in Finnmark and therefore this median date of capture is not comparable to the corresponding dates of wild salmon (See Figure 8). In male wild salmon the median dates of capture are more or less the same for previous spawners, 2SW and 3-4SW salmon (Figure 10). When analyzing all the material together in Kolarctic area it is obvious that previous spawners ascended first to the coastal areas, 2SW and 3-4SW salmon are caught simultaneously like 1SW and escaped salmon, too.
Figure 11. Weekly salmon catches in terms of numbers (figure on the top) and weekly sea-age distributions from numbers of salmon (figure below) in Finnmark, Troms and Nordland fishing methods combined.
In general when talking about salmon catches the information is mainly the total weight caught at sea or in the rivers and seldom the numbers of salmon. In the Kolarctic area (Nordland, Troms, Finnmark) the sampling in 2012 included c. 40% of 1SW salmon in terms of numbers (Table I, Figure 6) but if we are considering the catch in terms of mass then 1SW salmon made only c. 22% from the total catches.

Salmon catches had one clear peak at the same week, 28, all the counties combined (Figure 8) and in females the peak was in Troms and Finnmark two-three weeks earlier than in males (Figures 11, 12). In MSW female salmon catches especially in Finnmark there was steady increase in the numbers of large salmon from the week 20 to the week 25 followed by steady weakening towards autumn. In all Kolarctic areas escaped salmon are making contributions to the weekly catches and with especial high proportions in female salmon catches in Nordland in the end of the season (Figure 11). In Kolarctic area MSW salmon is making the majority in female salmon catches throughout the entire season and in male salmon catches MSW salmon are making more than 50% until the beginning of the week 25 in Finnmark and week 26 in Troms and Nordland. From the week 27 onwards 1SW salmon is making c. 50% from the catches in Finnmark and Troms during 5 weeks (to the end of ordinary fishing time). After the ordinary fishing time from August 4 onwards there is still some but minor migration of wild 1SW, 2SW and 3SW salmon and especially escaped salmon and in all areas the proportions of escaped salmon are high.

By comparing the information between the figures 11 (=numbers of salmon) and 12 (=weight of salmon) we can observe that 1SW salmon doesn’t mean so much in the catches in terms of weight than in terms of numbers. The economical value of MSW salmon in the sea catches is clearer to observe in the figure 12 than in the figure 11. During the peak migration time of the smallest salmon in Finnmark 1SW salmon is making only c. 30-35% from the catches in terms of weight compared to c. 60% in terms of numbers of fish. These figures are highlighting the high value of MSW salmon through May to the end of July not only from the point of economy for sea salmon fisherman but also from the point of the ecology of salmon. Large salmon, larger than 3 kg and older than 1SW fish, is usually female salmon belonging to higher prize category and from ecological point of view producing more juveniles than 1SW females.
Figure 12. Weekly salmon catches in three counties in Kolarctic area in terms of weight (figure on the top) and weekly sea-age distributions from weight of salmon (figure below) in Finnmark, Troms and Nordland fishing methods combined.
Cumulative percentages of the catches in terms of numbers for wild 1-4SW salmon and for escaped salmon in Nordland, Troms and Finnmark between May to August 4.

Cumulative percentages of the catches in Finnmark and Troms were close to each other for females and males in 1-4SW salmon and escaped salmon (Figure 13). That confirms the similar migratory behavior of wild salmon for all the sea-age groups and for escaped salmon within a larger geographical area in Northern Norway. Material from Nordland in the year 2012 indicates for example that 2SW salmon is ascending into the coastal areas earlier than 3-4SW salmon and escaped male salmon is occurring early in the summer in the catches.

Figure 13. Cumulative percentages of the catches in terms of numbers for wild 1-4SW salmon and for escaped salmon in Nordland, Troms and Finnmark between May to August 4.
Females and males in 1SW and 3-4SW salmon are migrating almost at the same time in Troms and Finnmark (Figure 14). In 2SW salmon, however, females are migrating earlier than males in Troms and Finnmark. In Nordland females in 1SW salmon are migrating earlier than males. In escaped salmon females tend to migrate earlier than males in Troms and Finnmark but in Nordland male escaped salmon catches accumulated earlier than female catches.
Figure 15. Median dates with 25% and 75% interquartile range of the catches in terms of numbers for wild 1-4SW salmon and for escaped salmon in Nordland, Troms and Finnmark between May to August 4.
Median dates with 25% and 75% interquartile range of the salmon catches can be used as one tool for management purposes to regulate, if necessary, the fishery before, after or during the peak migration. The figure 15 with median dates of the catches confirms the fact from the different migration periods between sea-age groups which were observed from the cumulative catches illustrated in the figures 13 and 14. Especially median dates of catches in Finnmark and Troms have high similarity among all the sea-ages of wild salmon and escaped salmon. It is noteworthy that the interquartile period especially in Finnmark is much shorter in 1SW female and male salmon than in 2SW, 3-4SW and escaped salmon. This indicates that the main proportion of 1SW salmon catch is accumulating in shorter time frame than in other sea-age groups and in escaped salmon.

Finnmark can be divided into three distinct areas, West- (from Loppa to Porsanger), Middle- (from Lebesby to Berlevåg) and East-Finnmark (from Båtsfjord to Sør-Varanger), where the timing of salmon migrations is differing between areas. The differences can be observed from the differences in the timing of the peak migrations for 1SW, 2SW and 3-4SW salmon as well as for escaped salmon (Figures 16 and 17). The proportion of 1SW fish is in general low in female salmon catches being lowest in West- and Middle Finnmark and highest in East-Finnmark. In East-Finnmark the proportion of 1SW females was almost 50% in female salmon catches in the week 29. In male salmon catches the proportion of 1SW fish is very high in the middle of the summer in all Finnmark areas and especially in East-Finnmark where it made c. 90% in male salmon catches in the weeks 27-29.

The same kind of difference between the median dates of catches for 1SW, 2SW, 3-4SW and escaped salmon which was found between the three northern counties can be found also between the three areas in Finnmark (Figure 18). Median dates of catches for female salmon are earlier compared to the dates of males in the sea-age groups of 1SW and 2SW wild salmon and escaped salmon but not for 3-4SW salmon.

Photo 3. Fisherman and sheep farmer Jakob Mikkelsen fish in Vardø, Kiberg.
Figure 16. Weekly salmon catches in West-Finnmark (from Loppa to Porsanger), in Middle-Finnmark (from Lebesby to Berlevåg) and in East-Finnmark (from Båtsfjord to Sør-Varanger) in terms of numbers (figure on the top) and weekly sea-age distributions from numbers of salmon (figure below).
Figure 17. Weekly salmon catches in West-Finnmark (from Loppa to Porsanger), in Middle-Finnmark (from Lebesby to Berlevåg) and in East-Finnmark (from Båtsfjord to Sør-Varanger) in terms of weight (figure on the top) and weekly sea-age distributions from weight of salmon (figure below).
3. Catches in bag net and bend net fishery were composed out of six groups of salmon

In the Kolarctic area in North Norway salmon catches included six groups of salmon; 1SW, 2SW, 3SW, previous spawners and escaped salmon. The occurrence of 4SW salmon was very low. The following conclusions can be drawn from the material collected by salmon fishermen in 2012 during the whole summer period from May to early September (Figure 19):

- proportions of 1SW salmon in the catches increased with the increasing latitude; that was true for females and males separately

- proportions of escaped salmon decreased with the increasing latitude; that was true for females and males separately

- each fifth salmon in Nordland was escaped fish, in Troms each tenth salmon and in Finnmark little less than each tenth salmon was escaped fish
-highest proportion of 2SW salmon was caught in Nordland

-the proportion of 3SW salmon was highest in Troms and very low in Nordland

-in bag net fishery the proportion of 1SW salmon was much higher than in bend net fishery and that was true especially in Finnmark and Troms

-in bend net and bag net fishery the proportions of MSW fish in females were almost equal between the fishing methods in Finnmark but in Troms bend nets selected higher proportion MSW females than bag nets

-in bend nets the mesh sizes are larger than in bag nets and therefore smaller salmon, like 1SW females, are escaping from bend nets (swimming through the meshes)

-in bag nets with the minimum mesh sizes, with 58 mm from knot to knot, most of salmon of 1-5SW fish will be caught except the smallest ones with the weight of 0.6-1.5 kg can swim through the net

Figure 19. Sea-age distributions of salmon catches from the numbers (figure on the top) and weights (figure below) of salmon for Nordland, Troms and Finnmark in bend nets and bag nets in May-September.
Figure 20 illustrates the timing of salmon catches caught with bend net and bag net in Kolarctic area. Fishermen started the fishery with bend nets for practical reasons because the use of bag nets early in May is not so successful. The use of bag nets is also more difficult and needs more manpower than bend net fishery. Most probably the catch early in May consists from large fish and therefore fishermen used bend nets where it is possible to use larger and more effective mesh sizes during the early migration period of large fish. Later in the season fishermen are using smaller mesh sizes to catch smaller salmon. In the year 2012 bag net fishery and bend net fishery targeted almost equally in the middle of the summer to 1SW fish. Figure 20 and there especially the bend net catches are illustrating clearly timing of wild and escaped salmon in the Northernmost Norway at the time when wild salmon is actively moving towards its home rivers.

Figure 20. Weekly salmon catches in terms of numbers (figure on the left) and weights (figure on the right) in the Kolarctic area (Nordland, Troms, Finnmark) in bend nets and bag nets in May-September.
Figure 21. Weekly salmon catches in terms of numbers (on the left) and in weight (on the right) in Finnmark county in bend nets and bag nets in May-September.

Figure 21 illustrates the weekly catches and sea-age distributions in Finnmark for bend nets and bag nets. Especially bend net catches are indicating migration patterns during the entire summer period. There might be some but minor migration also before May especially in female MSW salmon. Salmon catch caught only with bag nets in Finnmark doesn’t explain the migratory patterns of wild 1-4SW salmon, previous spawners or escaped salmon due to the limited period when fishermen like to use those old methods.

4. Many sea-ages in each of the three size groups of salmon

In the Norwegian official catch statistics salmon smaller than 3 kg has been understood to be a fish with the sea-age of 1 sea winter called also to grilse. Salmon of the sea-age of 2SW has been combined to belong to the size group of 3-7 kg salmon and salmon of 3SW to the size group of larger than 7 kg fish. The growth of salmon at sea, however, has varied annually a lot and also declined in the latest years and therefore some 2SW fish are belonging to the smallest size group as well as some previous spawners and escaped salmon (Figure 22). Most of salmon belonging to the size group smaller than 3 kg which were caught before the week 24 in Troms and Finnmark were actually 2SW fish. From the week 26 onwards in Finnmark and in Troms most of salmon belonging to the size category smaller than 3 kg were 1SW fish coinciding with the
time period of 1SW fish migrations between c. June 15 and August 4. The size category 3-7 kg fish includes salmon of 1SW, 2SW, 3SW, previous spawners and escaped salmon with varying proportions throughout the summer and the weekly age distributions are almost the same in Troms and Finnmark. In the summer the maximum percentage of 2SW salmon within the weekly catches of 3-7 kg salmon was c. 75%. The proportions of 1SW salmon increased steadily and clearly in Finnmark from the week 24 to the week 31. During the last week of the official fishing time before August 4 c. 30% from the salmon catches in the size category of 3-7 kg fish were escaped salmon in Finnmark (Figure 22). In Troms county in the size category of 3-7 kg the proportion of 2SW salmon declined steadily from the very beginning of July of 70% towards August 4 to smaller than 25%. In Troms county in the end of July and begin of August the proportion of escaped salmon was as high as 40% from the fishes in the size category 3-7 kg salmon. In West Finnmark the proportion of escaped salmon was in the size group of 3-7 kg salmon c. 30% in the end of the official fishing time in the week 31 and stayed the same to the end of August (Figure 23).

Figures 22 and 23 are indicating that it is necessary to cover the entire official fishing time in scale sampling if and when estimating the weekly and seasonal numbers of wild 1-4SW salmon, previous spawners and escaped salmon from the official catch statistics, where catches have been reported separately for the size groups of <3 kg, 3-7 kg and >7 kg salmon. If assuming that all the fish in the official catch statistics which are belonging into the size group smaller than 3 kg are 1SW salmon, or all fish in the size group of 3-7 kg are 2SW salmon, that is resulting to wrong conclusions when estimating f. ex. the status of salmon stocks especially for 2SW and 3SW salmon.

Figure 22. Sea age distributions in three size groups of salmon in terms of numbers in Kolarctic area.
Figure 23. Sea age distributions in three size groups of salmon in terms of numbers in Finnmark.

The proportions of sea-age groups among salmon below three kilos are about the same in West-, Middle- and East-Finnmark throughout the entire migratory period between May to the end of August (Figure 23). In the size group of 3-7 kg salmon there is higher proportion of escaped salmon in West-Finnmark than in Middle- and East-Finnmark throughout most of the official fishing time. Remarkable information from the research fishery in the year 2012 was that in East Finnmark almost 40-45% from salmon belonging into the size group of 3-7 kg was escaped salmon in the weeks 32 and 33 and a little less in West- and Middle-Finnmark.

5. Sex distributions of wild and escaped salmon

Knowledge on the sex ratio, proportion of females especially, in wild 1-4 SW salmon, previous spawner and in escaped salmon catches is one of the most important ecological factors related closely to the management of the fishery and thereafter to the juvenile production. Sex ratio information is not yet used effectively in salmon management. It should be used as an argument in the much better and successful management of salmon fishery at sea and in the rivers when reducing spatially and or temporally exploitation towards medium and large size female salmon for the weakened stocks.

The material from salmon collected in Kolarctic project concerning sex ratios covers the entire migratory period of salmon in the coastal areas and hence it indicates reliably the mean values for each age groups
presented here. In Nordland County the proportion of females exceeded clearly that of males in the total wild salmon catches. Main reason to that was lower abundance and proportion of 1SW salmon in the catches compared to Troms and Finnmark catches. In Nordland the fishery targeted more towards MSW salmon, where the proportion of females is higher than in 1SW salmon. In Troms and Finnmark females and males in the total wild salmon catches represented equal proportions between the counties. In the entire Kolarctic area males were major sex in 1SW salmon (82%) but females represented with 74% in 2SW and with 83% in 3SW salmon and females exceeded females also in 4SW salmon with the proportion of 58% (Figure 24). These sex ratios are indicating the mean values from the entire salmon migratory period between May and September and during the ordinary, much shorter fishing season values are not the same and might differ between Nordland, Troms and Finnmark due to different official fishing seasons. In 1SW salmon the proportion of females declined with the increasing latitude; in Nordland, Troms and Finnmark 1SW females represented with 31%, 21% and 16%, respectively, but the female proportions decreased towards north in escaped salmon being 70%, 44% and 38%, respectively. The higher proportion of females in 1SW salmon in Nordland and Troms compared to Finnmark might be caused from the fishing method used. In Nordland and Troms the only method allowed in salmon net fishery at sea is bag net which is usually equipped with small 58 mm mesh sized net. Therefore bag net is selecting smaller 1SW salmon where the proportions of females is higher compared to larger 1SW salmon with high proportions of males. In Finnmark, however, the usual fishing method is bend net with larger mesh sizes than which is used in bag nets and these bend nets are therefore selecting larger 1SW salmon where the proportion of males is exceeding that of females. The proportion of males in previous spawners was in Norland, Troms and Finnmark 45%, 34% and 40%, respectively. In Finnmark the proportions of females in 2SW and 3SW salmon were 75% and 85% and in Troms county 73% and 81%, respectively.

Photo 5. Typical size (c. 4 kg) of salmon in catches in year 2012. Female salmon below and male above it.
Figure 24. Sex distributions for wild 1SW, 2SW, 3SW, 4SW and previous spawning salmon, for escaped salmon and only for all wild salmon all sea-ages combined in three areas in Northern Norway and in the whole Kolarctic area between May and September.

Sex distributions changed throughout the entire migratory period in all wild salmon age groups and also in escaped salmon towards the majority of males in the end of summer (Figure 25). Females had clear majority especially in 3SW salmon but they had high proportion also in 2SW fish early in the summer. This indicates that female salmon generally ascended to the coastal areas clearly before the migration of males. Males were almost exclusively in 1SW salmon migrating in the coastal areas later in the season. Interesting, females also in previous spawners were the major sex until the end of June. In the wild salmon catches all sea-ages combined females dominated clearly until the second last week of June followed by the steady declining in their proportion later on in June and early July. During the second week of July and thereafter the proportion of females in the entire wild salmon catches stayed c. 25% to the end of September.
Figure 25. Weekly sex distributions for wild and escaped salmon in Kolarctic area.
Figure 26. Sex distributions for 1-4SW salmon, previous spawners and escaped salmon according to the lengths in 3 cm intervals.
Sex ratios are changing in each of the sea-age groups of salmon along the length of fish and that is most pronounced for 3SW salmon where the largest fishes were only males but females exceeded males clearly in smaller 3SW salmon up to the length of c. 100 cm (Figure 26). Within the smallest 1SW salmon (below c. 50 cm) the proportion of females was 25% but decreased to 10% in 1SW salmon with the length between 55 cm and 65 cm. Also in 2SW salmon the proportion of females declined with the increasing length of fish from the length of 75 to 85 cm.

Figure 27. Sex ratios for wild salmon (first time spawners and previous spawners) (figure on the left) and for escaped salmon (figure on the right) against length and weight.

The proportions of females are varying a lot against the length and weight of wild salmon (Figure 27). In general, the occurrence of females was low (c. 25%) in salmon smaller than 3 kilos corresponding the length smaller than 65 cm. Then females exceeded with 70%-80% the proportions of males in fish between the weights from 3.5 kilos up to 12 kilos. The proportions of females declined clearly after salmon reached the size of 12 kg and length of more than 100 cm.

Sex ratios in escaped salmon are different in most of the size groups compared to wild salmon although there are not so big differences in the proportions of females between all wild and all escaped salmon catches in Kolarctic area (see the Figure 24). The proportion of females in escaped salmon catches increased with the increasing length and weight which is opposite to the development in wild salmon.
6. Length and weight of salmon

Figure 28. Length and weight distributions for wild 1-4SW salmon, previous spawners and escaped salmon in the Kolarctic area at sea.

Length and weight distributions are differing between females and males in wild salmon (Figure 28). Reasons for that are the differences in the sea-age distributions between sexes. Small sized 1SW salmon in male salmon catches are more numerous than in females where 2SW and 3SW salmon are making the majority. Three size groups can quite clearly be identified in the length distribution of wild female salmon but in males only one clear size group can be observed. There is only one peak in length and weight distributions of female and male escaped salmon.
In Nordland, Troms and Finnmark the mean lengths and especially weights of escaped male salmon were clearly larger than those for wild salmon. Also mean lengths and especially weights of escaped female salmon were larger than those for wild salmon (Figure 29). In the catches escaped salmon are looking like much fatter than its wild counterpart of the same size.

Figure 29. Mean lengths and weights of wild and escaped salmon in Kolarctic area.
Length distributions of salmon caught with bend nets and bag nets are indicating that in July there are not so clear differences as expected in the length distributions for females and males or salmon in general. Some selection in the size of salmon between the fishing gears, however, can be detected in May and June. The selection in the size of salmon is understandable because the mesh sizes in the bag nets are usually...
close to the minimum of 58 mm from knot to knot but the mesh sizes in bend nets is variable during the season but must be at least 58 mm. Fishermen are also changing sometimes the bend nets with smaller mesh sizes to the nets with larger mesh sizes. Early in the season when large salmon is migrating along the coast fishermen are using sometimes mesh sizes larger than 70 mm from knot to knot but generally they are using mesh sizes between 62-68 mm in bend nets. In July, however, when smaller sized 1SW salmon is migrating in large amounts along the coasts bend nets are targeting more to larger 1SW salmon and towards 2SW and 3SW females than the bag net fishery (Figure 30). Bag net fishery in July with smaller mesh sizes in nets is catching also small sized 1SW female salmon. From the total catch caught between May and beginning of August in Kolarctic area bend net fishery is targeting more towards larger salmon than the bag net fishery.

Figure 31. Length distributions of wild 1-3SW salmon and escaped salmon in Nordland, Troms and Finnmark.
In all the three counties in Northern Norway the length distributions of salmon were close to each other for the sea-age groups 1SW, 2SW and 3SW and also for escaped salmon (Figure 31). Length distributions of escaped salmon are indicating wide range and they are overlapping all the wild 1SW, 2SW and 3SW salmon length distributions. The size distributions of 1SW and 2SW salmon between three counties are giving a general picture from the size selective fishery indicating that in Finnmark the size of 1SW salmon in the catches is smaller for 1SW than in Nordland and Troms and the size of 2SW salmon is larger in Finnmark catches than in Nordland and Troms. Differences in the size distributions between counties are affected by methods and mesh sizes used, timing of the sampling in the summer and growth differences in the stocks exploited within these areas.

Figure 32. Length and weight distributions for wild and escaped salmon caught in May-September in the Kolarctic area.
Length distributions combining all the lengths of wild 1SW-4SW salmon is giving a crude view from the ages of salmon available in the fishery (Figure 32). There is, however, extensive overlapping in the lengths and weights between the ages of 1SW and 2SW, 2SW and 3SW, 3SW and 4SW salmon that makes it impossible to use length and weight groups to identify ages of salmon from the material which is collected during three-five summer months. Length and weight distributions of previous spawners and escaped salmon combined into the wild salmon distributions are increasing the difficulty of separating sea-ages in the salmon catches. Wide range of the distributions in each sea-age group is depending from the different salmon stocks included into the material and the large time span in the collection of the material from May to September.

![Graphs showing length and weight distributions for different sea-ages in three counties and the entire Kolarctic area](image)

Figure 33. The proportions of wild 1SW, 2SW, 3SW, 4SW salmon, previous spawners and escaped salmon in each length and weight groups in three counties and in the entire Kolarctic area in the salmon catches caught between May and September.

There are up to four groups of salmon in the transition to larger salmon in the length and weight groups (Figure 33). The proportions of escaped salmon are covering almost all the size groups with quite high prevalence in all the counties. Escaped salmon represents with its high proportions its important occurrence within the medium sized salmon catches.
Figure 34. Size distributions of 1SW, 2SW, 3SW wild salmon and escaped salmon caught with bag nets and bend nets in Nordland, Troms and Finnmark and counties combined between May and September.
Two salmon fishing methods, bag net and bend net, have different ways to catch fish. The oldest method is bag net. It is catching salmon usually alive into the bag, at least those fishes which are larger than 1SW old. In bag nets fishes will be gathered into special chamber or chambers into where salmon must swim through narrow opening(s). The smallest 1SW fishes can escape through the mesh sizes but the largest 1SW fish will remain in the net when trying to escape through the mesh and usually they are dying after short period. Bag nets are in a manner selective fishing gears selecting the largest fishes in 1SW salmon group and the smallest may escape in that age group.

Bend net is catching salmon only with the meshes when salmon is trying to escape out from the gear. Salmon is attaching into the gillnet. Fishermen are also using variable mesh sizes in the bend nets during the season. Early in the season when 3SW and 4SW salmon is migrating along the coastal areas fishermen are using larger mesh sized nets to capture more effectively large salmon. Later in the season when 2SW and 1SW salmon have their migrations fishermen start to catch salmon with smaller mesh sized nets in bend net fishery. Usually the mesh sizes are from 62 mm to 68 mm between knot to knot and especially the smallest 1SW salmon can escape these nets.

The length distributions of 1SW salmon caught with bag nets and bend nets through the period from early May to the beginning of September are indicating that there are not so remarkable differences in the sizes of salmon between these two methods (Figure 34). Bag net fishery is targeting, however, into slightly larger 1SW salmon that bend net fishery. Reason for those differences in the size distributions might be that those two fishing methods have not been used at the same time of the summer and therefore the figure doesn’t indicate exactly the possible size selective fishing of bend nets. Size distributions of 2SW salmon in Finnmark are indicating that bend nets are catching a little larger salmon than bag nets. In the catch of 3SW salmon and escaped salmon no clear differences can be observed in the size distributions between the two methods.

Photo 6. Female wild salmon, nice silvery colour, and in extremely good condition (indicating good feeding conditions somewhere at sea), caught in Varangerfjord
The weekly mean lengths and weights of wild and escaped female salmon caught in Kolarctic area were almost unchanged throughout the period from May to early September (Figure 35). One reason to that is the very small change in the weekly sea-age distributions of wild female salmon during the entire migration period which could affect to the weekly mean sizes in female salmon catches (Figure 8). The low abundance and thereafter the low proportion of female 1SW salmon only in the middle of the summer in the catches did not affect substantially to the mean sizes of females.

In male salmon, however, the weekly mean sizes of wild salmon declined from the week number 20 to the week number 28 and thereafter mean sizes stayed quite stable to the week 37. This declining of the mean sizes of wild salmon is caused by the high abundance and proportion of 1SW males in the catches over 10 weeks (Figure 8). In male escaped salmon the weekly mean sizes varied early in the season due to their low abundance in the catches and the sizes declined slightly towards autumn.
Figure 36. Weekly mean lengths of wild and escaped salmon in Nordland, Troms and Finnmark counties.
Salmon catches in the coastal areas in Nordland, Troms and Finnmark are consisting approximately from 200-250 salmon stocks. It is believed that each of these stocks is migrating within a quite narrow time frame along the coastal line and therefore the mean weekly sizes of salmon do not differ much in each sea-age groups. The most obvious observation was the clear increase in the weekly mean sizes of 2SW females in all the counties (Figure 36 and 37). There was also slight increase in the mean weekly length of female 3SW fish. The larger weekly mean lengths of 2SW females in the end of the migration might be explained that those fishes were so called late running salmon and they have had some additional growth during the third summer at sea. The increase of the size of 1SW salmon towards autumn can increase their catch ability in bend net fishery. The increase in the size of salmon in each sea-age groups towards autumn can be explained by the difference in the migration periods of the various stocks when those stocks migrating later have continued their growth. Differences in the weekly mean weights and lengths between the three counties can be explained by the differences in stocks components.

Photo 7. Fisherman Øystein Kristiansen from Nesseby (Klubbvik) in Varanger fjord, registering the number of salmon lice precisely, before taking all the other required information and consequently a scale sample.
Figure 37. Weekly mean weights of wild and escaped salmon in Nordland, Troms and Finnmark counties.
Based on the material collected in Finnmark it seems that the mean weekly sizes of 1SW and 2SW female and male salmon in bag net and bend net fishery are differing slightly (Figure 38). These differences can be caused for example by the use of varying mesh sizes in bend nets during the fishing period.
Figure 39. Mean lengths and weights of wild 1-4SW and previous spawned salmon in Kolarctic area from May to August 4.

Mean weights of 1SW, 2SW, 3SW and 4SW wild salmon and escaped salmon were almost the same in Troms and Finnmark (Figure 39).
Bend nets selected larger 1SW salmon than bag nets in Nordland and Troms in terms of length and weight of fishes (Figure 40). In Finnmark there were no clear differences in the mean sizes of 1SW and 2SW salmon between bag net and bend net. One reason to the size differences in 1SW and 2SW salmon between the fishing methods can be differences in the time when these methods were used. If bend nets were more effectively in the end of the season than bag nets then it is obvious that they are explaining the larger sizes of 1SW and 2SW salmon. In the end of the fishing season 1SW salmon and 2SW salmon are larger than early in the summer (Figures 36 and 37) due to the additional growth during the summer.

Figure 40. Mean lengths and weights of wild 1-4 SW and previous spawned salmon in bag net and bend net fishing in Kolarctic area between May to August 4.
7. Escaped salmon in the salmon fishery in Northern Norway

Escaped salmon occurred in the catches in all the counties (Figure 6), in all the months (Figure 7), in all the weeks (Figure 9) and in all the fishermen’s catches (Figures 4). Most of the fishermen who were collecting material from salmon for Kolarctic project in Finnmark were instructed to recognize escaped salmon from their wild counterparts in the salmon catches. In Nordland and Toms escaped salmon has occurred in the catches over many years due to the extensive salmon cage production and escaped salmon from the cages. Escaped salmon has occurred in the catches in Kolarctic area since the second half of 1980s’. Therefore it was expected that fishermen should be aware to make recognition between wild and escaped salmon. There have also been a lot of official brochures with informative photos in Norway to inform all salmon fishermen how the escaped salmon looks like. In general salmon fishermen recognized only half from the real abundance of escaped salmon which were later identified by scale analysis to be escaped salmon (Figure 41). Only very few wild salmon were identified wrongly by the professional fishermen to be escaped salmon. In careful scale reading it was found c. 50% more escaped salmon, which fishermen identified to be wild salmon. There were some clear differences between the counties to make correct identification on the escaped salmon. In Nordland and Finnmark fishermen recognized c. 50% and in Toms c. 60% from all escaped salmon to be escaped.

Figure 41. Recognition percentages of escaped salmon identified by fisherman out of all escaped salmon and confirmed by scale reading. Green color indicates the proportions of escaped salmon identified by fishermen out of all escaped salmon. Red color indicates the proportions of escaped salmon identified by scale reading. Fishermen in Toms could identify salmon more precisely to be escaped than fishermen in Finnmark and Nordland.
Figure 42. Recognition of salmon to be escaped salmon by fisherman and by scale reading in each size groups of salmon. Fishermen recognized more precise salmon to be escaped salmon with the increased size of fish.

Juvenile salmon which is used for cage culture at sea is growing its first 8-10 months in freshwater tanks. Juveniles are growing in large schools and their growth in length and weight is fast compared to the growth in natural conditions. Due to the high population density and unnatural living conditions in tanks juvenile salmon have some erosions in the edges of pectoral and dorsal fins and also the tail can be rounded already in smolt phase. After releasing smolts into the net pens at sea they start the fast seawater growth which takes 1-2 years before they will be slaughtered. The longer time the salmon is in the net pens the larger and clearer are the damages especially in the fins and the clearer is the shortening of the gill cover compared to those of wild salmon. Therefore it was understandable that fishermen couldn’t recognize the smallest escaped fish to be escaped because these fishes had not yet been so long time in cages (Figure 42). From the figure 42 it can easily see that the recognition is getting better with the increase in the length and weight of escaped salmon. Fishermen had best practice to identify escaped salmon with the weight of 6-7
kilo and with the length of 75-85 cm salmon. That might indicate that those fishes had stayed in the net pens rather long time before escaping and during that period they had experienced clear erosions in fins and gill covers. If salmon is escaping rather soon after the transfer into the salt water, from some months to not more than one year, it is not so easy for a fisherman to recognize it to be escaped salmon. Fishermen succeeded to recognize 65-75% from escaped salmon to be real escaped salmon when the weight of escaped salmon was 4.5-8.5 kg.

Figure 43. Proportions of escaped salmon and wild salmon (first time spawners and previous spawners) in different length and weight groups in Kolarctic area at sea. Note that the proportion of escaped salmon is very low in one sea winter salmon length and weight groups but highest in 2 SW age groups.
Escaped salmon occurred almost in all the same weight and length groups where wild salmon is occurring (Figure 32). Its proportions were 25% in the weight groups of 5-7.5 kg salmon in the Kolarctic area which weight is corresponding to the length of 75-90 cm fish (Figure 43). The high proportion of escaped salmon mainly in the above mentioned size groups can have two explanations. If the escapement from net pens takes place in their very early ocean life phase then these escaped salmon might migrate straight away to oceanic feeding grounds avoiding to be caught like small sized wild salmon in the coastal areas and therefore their proportions are small in small size group salmon. If cage culture salmon is escaping in its later life phase its natural mortality might not be as high as with salmon escaping in younger phase and therefore their proportion is higher in larger fish. Another thing and maybe the most important thing is that there are not so many wild 2SW and 3SW salmon in the weight groups of 5-7.5 kg fish and therefore the proportion of escaped salmon is there large (see the figure 32).

8. Salmon lice; occurrence in wild and escaped salmon

Salmon lice (*Lepeophtheirus salmonis*) is a common parasite on salmon. It is a crustacean belonging to the large group of *Crustacea* and it occurs at sea in northern hemisphere. This parasite is living only on the salmon and therefore it is called to be ectoparasite. Salmon can be attracted by the larvae of this parasite already in very early phase of the sea life as smolt or post smolt. Parasite is attached mainly into such a places of the fish body, where they are “sheltered” against the water current. Parasite is feeding mucus and sucking blood from fish. If the number of parasite is high that can affect negatively to the survival, growth etc of the host. Parasite can also carry bacterial or virus diseases that can be transported to wild salmon stocks from salmon cage culture.

*Photo 8. Salmon lice.*
Figure 44. Mean numbers (+SD) of salmon lice in different sized wild and escaped salmon in Finnmark, Troms and Nordland and in the total Kolarctic area.

Fishermen were asked to count the numbers of salmon lice from all their catches. The mean numbers of lice are the minimum values. All the salmon were caught with nets and some lice certainly were falling when fishermen took salmon away from the net although salmon lice is usually attached strongly into the body of salmon. The mean numbers of salmon parasite did not differ so much with the increase of the fish.
length (Figure 44). In Nordland the highest mean number of parasite was in salmon with the length of 85-100 cm.

![Graphs showing mean weekly numbers of salmon lice in different salmon categories over weeks.](image)

*Figure 45. Mean weekly numbers of salmon lice in wild 1SW, 2SW, 3-4SW salmon and previous spawners and in escaped salmon in Kolarctic area.*

The mean weekly numbers of salmon lice in salmon increased along the summer. Early in the summer in May the mean numbers of lice were c. 5 in wild and escaped salmon (Figure 45).
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