MONITORING HATCHERY USE OF SPAWNING WALLEYE IN LAKE DIEFENBAKER, SASKATCHEWAN (CANADA)

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Introduction. Saskatchewan is a prairie province with most of its human population residing in the southern agricultural region. Many lakes in this area are shallow and mesotrophic or eutrophic, summers are often sunny and dry and winters long, and watercourses are fragmented by barriers.

Walleye (Sander vitreus, formerly Stizostedion vitreum) fry are stocked annually to mitigate winterkill and supplement natural recruitment. Since 1950, several spawning populations have been used to obtain eggs for stocking over 50 lakes annually. Since 1991, the walleye that spawn in Coteau Bay of Lake Diefenbaker have been the sole source of 60 to 100 million eggs annually for this program. An assessment of the sustainability of hatchery operations seemed advisable.

Lake Diefenbaker was impounded in 1967 for hydro-electric, irrigation, and recreational use. It is 222 km long and has an area of 43,000 ha. About 1/4 of the lake is deeper than 30 m and the maximum is 59 m (Royer 1972). Winter draw-downs range up to 11 m. Coteau Bay is adjacent to Gardiner Dam, about 4 km long, and a maximum of 15 m deep.

After initial stocking of several fish species, angling increased slowly and moved from northern pike (Esox lucius) to walleye. The lake now ranks first or second in recent angler surveys (Joerissen and Brickley 1998).

Figure 1. Lake Diefenbaker showing Coteau Bay (large circle) and two other sites (small circles).

Methods. Fish culture station (FCS) staff used trampnets to catch fish in late April to early May, collected eggs from ripe females, held others in pens up to 3 days for ripening, and shipped eggs to the hatchery. They monitored indices annually from 1991: numbers of walleye and other species, numbers of female and male walleye, average eggs obtained per female, and % hatch. Fishing efforts, waterlevels, and water temperatures were recorded.

Initially, only walleye caught during hatchery operations in Coteau Bay were examined. Later, assessment crews trapped at two other sites: Qu’Appelle Arm (Aiktorw and Fordes creeks) and Birsay area (Hitchcock and Sage bays).

Assessment covered four main topics, from microscale to ecosystem-wide:
1) FCS monitoring and additional indices of egg quality (as ‘egg dry mass’) and stress from handling (by ‘lymphocystis’ rates). Samples of eggs were expressed, frozen, and two replicates of 30 eggs were counted, dried 24 hours at 60°C, and weighed.
2) Sizes and age compositions at several sites. Ageing of dorsal spines was done for sub-samples and applied to length compositions.
3) Abundance of spawners at each site. Serially numbered tags were used for daily estimates (‘within year’ by Jolly-Seber) and batch tags for seasonal (‘year-to-year’ by Petersen). These required analyses of length of stay during spawning, tag-loss from double-tagging, mortality and recruitment, and homing.
4) Movements of walleye after spawning based on reports by anglers. Mixing of spawners among sites was assessed by staff to detect any net inflow into Coteau Bay from other sites. The 3 sites are 40 to 60 km from each other, and chosen to be within the observed range.

Results. Time series of FCS indices showed some variations and auto-correlations among years (all non-significant at p=0.05). Linear regressions showed no significant trends, and only one index was low in any year: % females in 2000 reached the lower 95% prediction limit for single observations. Some of the FCS indices are not easily standardized because staff adjust their fishing to maintain catches while ensuring proper care of the fish and eggs. Lower waterlevels in some years also increase catches noticeably, further confounding the situation.

Each year, staff examined 3,000 to 5,000 walleye at Coteau Bay and 100 to 900 at each of the other sites.

‘Egg dry mass’ averaged about 0.9 mg for 115 females, in line with data from Coteau Bay in 1997 and other populations. ‘Lymphocystis’ occurred on significantly more walleye at Coteau Bay than other sites (10% versus 3%). Rates reached 15% in females that were handled for both hatchery and tagging operations. Preliminary data from serial# tags suggest that the effects of different kinds of tags may vary.
Sizes of females ranged from 35 to 80 cm long and males 25 to 70 cm. Sizes, ages, and mortality rates were very similar at most sites.

<table>
<thead>
<tr>
<th>Sex and site</th>
<th>Ages (years)</th>
<th>Mortality (annual)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Females</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coteau Bay</td>
<td>6 to 20</td>
<td>19 %</td>
</tr>
<tr>
<td>Qu’Appelle</td>
<td>6 to 18</td>
<td>17 %</td>
</tr>
<tr>
<td>Birsay</td>
<td>6 to 19</td>
<td>17 %</td>
</tr>
<tr>
<td>Males</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coteau Bay</td>
<td>5 to 19</td>
<td>27 %</td>
</tr>
<tr>
<td>Qu’Appelle</td>
<td>5 to 11</td>
<td>38 %</td>
</tr>
<tr>
<td>Birsay</td>
<td>5 to 15</td>
<td>28 %</td>
</tr>
</tbody>
</table>

Daily mark-recapture estimates of abundance usually fluctuated and had wide confidence limits, if any. Estimates were not possible at Coteau Bay since most walleye were temporarily removed during penning. Recaptures at Qu’Appelle sites indicated stays averaged only 2 days and may suggest ‘staging’ in the open lake. About 9 % of fish tagged at Birsay in 2001 were recaptured at Coteau or Qu’Appelle sites within the same spawning season, implying considerable transience. Fish tagged further inside the Birsay bays in 2002 showed greater residency during spawning season.

Walleye abundances confirm that Coteau Bay is a major spawning site. Numbers of walleye averaged 15,800, comprised of 5,000 females and 10,000 males. Numbers were about 2,300 in the Qu’Appelle area and 2,100 in the Birsay area, based on year-to-year recaptures.

Anglers reported over 300 walleye from Coteau Bay were recaptured between May and December in the initial 3 years. Some walleye were 100 km up the lake by July and the furthest were 145 km along by September. This reflects both walleye movements and seasonal angler patterns. Some walleye remained in Coteau Bay all summer and longer.

Spawning walleye tended to return to the site used the previous spring. About 95 % returned to Coteau Bay and 91 % to Qu’Appelle sites, but only 65 % to Birsay sites in 2002. This means about 800 walleye arrived for the first time in Coteau Bay and about 800 walleye departed from Coteau for the other two areas. Data for 2003 should show if Birsay ‘residents’ tend to further reduce any inflow into Coteau Bay.

Discussion. Monitoring indices in place since 1991 suggest there are few, if any, concerns. Nonetheless, some indices need long periods to detect problems within the natural variability of walleye populations and may lag behind early effects.

Similar concerns about impacts from a similar longterm use of another spawning run in Saskatchewan showed changes, but a generally healthy population (Mathias et al. 1985).

Hatchery operations collected eggs from 480 to 920 females annually, and not all of the eggs in each fish. Actual usage is about 14 % of the 750 million eggs that could be collected, based on the total abundance of females in Coteau Bay. Continued stocking of fry into Coteau Bay may alleviate any residual concerns.

Several of the initial recommendations are in place, even as the study concludes. Egg collections have been fine-tuned to better reflect natural abundance each year, rather than demands for fry. Monitoring continues and more detailed indices (e.g. egg dry mass) are planned periodically. Lymphocystis rates require further analysis of the effects of tagging and periodic updates.

Spawning populations in Coteau Bay, Qu’Appelle Arm, and Birsay areas all show good size and age compositions and acceptably low mortality rates.

The population in Coteau Bay does not appear to be sustained by net inflows from other populations. Some mixing of spawners occurs between sites within the known range of walleye movements in Lake Diefenbaker. If spawners at all 12 to 20 known spawning sites behave similarly (given their relative distances from Coteau Bay), the balanced mixing into and out of this major site would remain.

Many aspects of walleye populations in Lake Diefenbaker are unknown and will likely remain so: identification and suitability of most spawning sites, total abundance of walleye in the lake, and genetics of the original riverine versus stocked fish and any sub-populations.

The effects of fishing harvests, catch-and-release angling, year-class variability, and past escapes of large numbers of fish from aquaculture facilities on walleye and other species may need examination. Meanwhile, habitat conditions in this reservoir continue to evolve.

Acknowledgements. Staff at the Fish Culture Station monitored operations from 1991 to present. Many staff and volunteers from the EcoRegion and Branch worked every spring on the lake. Tournament organizers for Elbow Wildlife Federation, Riverhurst Recreation Board, and Kyle Lions Club provided access to anglers, and enforcement staff summarized reports from anglers. Students and staff rechecked tag numbers and other data, aged fish, and reviewed drafts. Funding came from Branch and EcoRegion budgets and the provincial Fish and Wildlife Development Fund.


