

English Summary

Following publication of a report by the National Environmental Research Institute (NERI) in November 1996, presenting estimates of the extent of crippling of game species, the Minister of Environment and Energy charged the Danish Game Management Council with the task of preparing an action plan to reduce the extent of crippling.

A committee established by the Council presented the plan in May 1997, and official endorsement followed in June of that year. Hence, the action plan was implemented before the start of the hunting season 1997/98, and to date has been in effect for four years.

This report presents a status of the results of NERI's research during that period, carried out in agreement with the action plan. This research comprises:

- 1) Investigations of the extent of crippling amongst game species other than the four originally examined;
- 2) Monitoring the effects of the action plan for selected species used as indicators;
- 3) Investigations of hunting efficiency, aimed at assessing the extent to which crippling depends on hunting method;
- 4) Investigations of causes of crippling;
- 5) Investigations of the extent of serious crippling;
- 6) Investigations of the dependence of risk of crippling on shotgun shell quality.

The extent of crippling/wounding in various game species

Greylag geese were collected for examination in western Jutland in the autumn of 1999. Out of 41 X-rayed first-year geese, 3 (7.3%) carried shotgun pellets, while 32 out of 99 older geese (32.3%) carried pellets. Considering that the collection was carried out in September-October, when individuals in their first year still were at the start of their first hunting season, these re-

sults are comparable to those previously found for pink-footed geese. The results thus support the assumption that the extent of crippling is similar for all quarry goose species.

Out of 161 mallards examined in January 2001, 24 (14.9%) carried shotgun pellets. This result did not deviate significantly from those of two previous samples, and the overall estimate is thus that 15% of individuals of the species are pellet carriers.

Out of 185 woodpigeons examined in the autumn of 1999, 6 (3.2%) carried pellets.

Results on pellet carriers are presently available for a total of 12 out of the overall total of 40 species that may be hunted with a shotgun in Denmark. These 12 species are those for which crippling problems might be expected, and which at the same time make up the major part of the annual Danish bag, accounting for more than 2 million individuals out of a total annual bag of 2½-3 million.

It is concluded from these results that the extent of crippling is considerable for all larger species of waterfowl. Of five terrestrial game species investigated only the red fox showed substantial proportions of shotgun pellet carriers.

Monitoring of the effects of the action plan

The effects of the action plan are presently being monitored for three species, viz. the pink-footed goose, the common eider and the red fox.

Live pink-footed geese were caught by means of cannon-nets and X-rayed in late March 2000 (n = 160) and 2001 (n = 194). In all, 10.5% of the first-year individuals carried pellets, while 28.9% and 23.1%, respectively, of the older individuals carried pellets. These proportions are significantly lower than those found for samples taken during 1990-1996, when 24.6% of the first-year

and 36.0% of the older geese carried pellets. For this species it is concluded that the action plan has resulted in a decreasing proportion of birds carrying pellets. It is not yet possible to draw conclusive inference regarding the extent of the reduction, but the preliminary results obtained during 1998-2001 are taken to suggest that the annual number of crippled geese has been reduced by approximately half. Since only $\frac{2}{3}$ of the annual bag of this species is taken in Denmark, and since there is no reason to assume that reductions have taken place outside of Denmark, the net effect of the Danish action plan may therefore be as high as a 75% reduction.

Following an outbreak of avian cholera in April-May 2001, 418 dead common eider females were retrieved and X-rayed. Of these, 110 (26.3%) carried shotgun pellets. This proportion is significantly lower than the proportion found in 1995-1996, when 85 (34.1%) of a total of 249 examined specimens carried pellets. This reduction may not necessarily have been caused by effects of the action plan, since changes in the age structure of the colonies resulting from the 1996 epidemics could for example, explain the findings. Although, it is not yet possible to make any final conclusions, under the best possible case scenario, i.e. if the decrease in frequency of pellet carriers is exclusively caused by effects of the action plan, this would correspond to a 75% reduction of numbers crippled annually.

A total of 129 red foxes were collected and X-rayed in January and February 2001. Of these, 28 (21.7%) carried shotgun pellets. This frequency was not significantly different from that of samples collected in 1999, when 43 out of 173 (24.9%) examined specimens carried pellets. It is concluded that for the red fox no effects of the action plan can be found.

Risk of crippling during decoy and motorboat hunting of common eider

Data were collected for motorboat hunting of

common eider in October and November 1999. Range and result were recorded for a total of 139 individual shots, resulting in 104 bagged eiders. This means that 1.34 shotgun shells were expended for each bird bagged. Compared to previous investigations carried out in late winter (January and February 1997-1999), hunting effectiveness was significantly higher. In late winter hunting, 1.96 shells were expended for each bagged bird during motorboat hunting, and 1.65 during decoy hunting. Furthermore, the proportions of both lightly and seriously wounded birds (defined as wounded individuals that survive the hunt, but do not survive until the time when samples for X-raying were collected) were significantly higher for late winter hunting. Average range was not very different for autumn and late winter motorboat hunting, being 29.9 m and 33.4 m, respectively, and the differences in hunting efficiency thus cannot be fully explained in terms of shooting range variation, e.g. due to eiders being more shy and less approachable by boat in late winter. First-year individuals make up a significant proportion of eiders bagged in autumn, and at that time of the year they have not yet obtained full adult body mass. Thus, the results may imply that juvenile eiders are less robust and easier to kill in autumn than in winter. However, the data were collected on relatively few days with optimal weather conditions, and it is also possible that very favourable (completely calm) weather conditions during the autumn investigations may explain a large part of the difference.

The investigations described above were all carried out using 12-gauge shotguns. In order to evaluate the effects of gauge, a total of 21 eiders were shot on dispensation using a 10-gauge gun, a caliber that has not been legal for hunting in Denmark since 1931. Shell expenditure for this caliber was 2.00 per delivered duck. The difference in efficiency between 10- and 12-gauge shotguns was not statistically significant, but on the other hand nothing in the results suggest improved performance by using 10-gauge guns. It is suggested that the use of the relatively heavier 10-gauge guns may impair shooting precision when used at sea from motorboats, and it is concluded that reintroduction of the heavier caliber does not appear to lead to improvements in hunting efficiency.

Shooting efficiency and risk of crippling

In combination with the current Danish Game Act, the Danish Game Management Council published a set of recommendations for ethical hunting. For flying game, it is recommended that a maximum of three shotgun shells be expended per delivered bird. Furthermore the individual hunters should reduce their shooting range and/or increase their level of practising when that limit is exceeded.

Data from investigations of dusk hunting (i.e. until 1½ hours after sunset) of mallards, collected during the hunting seasons 1997/98-2000/01, were analysed in order to clarify the dependence of crippling risk on shooting efficiency. Out of 12 volunteer hunters, five used less than three shotgun shells per duck, while seven used more than three. Out of 163 shots recorded for the first group, 62 resulted in kills while 19 ducks were crippled. Out of 227 shots recorded for the latter group, 55 resulted in kills while 42 ducks were crippled. This difference is highly significant.

Following the field investigations, the 12 shooters participated in simulated test shootings using the so-called STANDPLASS-2000 simulator developed in Norway. The results verified the field observations. A detailed analysis of the hitting capabilities of individual shooters showed significant differences in the proportions of shots being placed within < 35 cm, 35-50 cm, and more than 50 cm of a virtual 'target', respectively. These proportions will determine individual crippling rates, defined as the ratio of crippling to killing. Moreover, participants having lower hitting efficiency fired a significantly higher proportion of their shots at ranges above 35 m, even in test situations where identical sequences of shooting events were presented. Average range depended significantly of the timelapse between detection of the target and delivery of the shot, and a large proportion upon the difference in individual average range was apparently caused by less efficient shooters expending more time shouldering and aiming their guns.

When taken together, these results clearly suggest that shooting efficiency has important im-

plications for the risk of crippling, the latter increasing as the former decreases.

Status of the action plan

The overall interim status of the action plan stands thus:

- 1) High proportions of individuals carrying shotgun pellets have mainly been found amongst waterfowl species. The proportion of pellet carriers is strongly correlated to body mass, and is highest for large, robust species that also have high annual survival rates. For a number of game species with small body mass (e.g. teal, common snipe and partridge) there seems to be no need for further investigations since it is virtually certain that the proportion of pellet carriers will be low. For terrestrial game species, a high proportion of pellet carriers has only been found in one case (red fox).
- 2) For pink-footed goose and common eider, significant decreases in proportions of pellet carriers have taken place over the period 1997-2001. In the case of the pink-footed goose it is concluded that the reduction occurred as a result of the action plan, and the results obtained so far suggest that the number of geese crippled annually has been reduced by 50%. If improvements have only taken place in Denmark, where $\frac{2}{3}$ of the annual bag of this flyway population is taken, the overall reduction may be 75% in this country. For the common eider, it is not known yet whether the decrease in the proportion of pellet carriers is a result of the action plan, but the best possible case scenario - i.e. that the reduction in frequency of birds carrying shotgun pellets is caused by improvements in hunting efficiency - suggests that up to a 75% reduction may have taken place also for this species. For the red fox, it is not possible to demonstrate improvements so far.
- 3) To date, the results show that the risk of crippling differs between the various hunting methods investigated. Hunting of pink-footed geese on morning flight from nocturnal roosts and motorboat hunting of common

eider generally results in longer shooting ranges than decoy hunting of the same species. However, if hunters restrict their shooting to ranges below 30 m, as recommended by the Danish Game Management Council, these methods of hunting do not appear to lead to demonstrably higher risks of crippling. Hunting of eiders from motorboat in autumn apparently had a lower risk of crippling, though it is presently unclear whether the improved efficiency was caused by first-autumn birds being less robust or by more favourable weather conditions. Hunting experience is evidently an important factor since the total crippling rate for eider hunting was ca 0.3 per bagged bird (only very experienced hunters participating), while the rate of crippling (only lighter cases recorded) for dusk hunting of mallard (some less experienced hunters included) was 0.6 per bagged bird.

4) At the time when the action plan was developed, very little was known about the causes of crippling. Based on practical experience, it was assumed that shooting at too long a range was the major cause of crippling, and accordingly the plan recommended a decrease in shooting range as the best remedial action. This assumption has been fully verified by all later investigations, but the results presented in this report clearly suggest that shooting accuracy is an equally important factor. The analyses of the results for dusk

hunting of mallards show that the risk of crippling is closely associated with the number of shotgun shells expended per duck delivered. Shooters that expend less than three shells per duck have less than half the crippling risk of shooters expending more than three shells. Since shell expenditure is also closely correlated with shooting range, it is recommended that this parameter is used as a better indicator (compared to shooting range) of hunting efficiency and crippling risk in the remaining period of the action plan. Increasing awareness of shell expenditure amongst hunters can make a significant contribution to the effectiveness of the action plan.

- 5) Investigations of the extent of the so-called 'serious' crippling, defined as the non-retrieved game that do not survive until the time when sampling for X-raying is carried out (shortly after the closing of the season) are difficult, and it is not yet possible to provide reliable assessments. Only in the case of hunting of common eiders can a reliable estimate be given. For this species, seriously crippled birds (able to escape by diving though not able to fly) make up a minimum of 10% of numbers bagged.
- 6) The implications of shotgun shell quality for crippling risk have been reported separately. At present, it is expected that minimum muzzle velocities will be established by Government order.