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Mismatch between planned and realized harvests: integrating hunter demography, harvest records and waterbird monitoring to inform game bird management in Poland

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Bird hunting, with deep historical and cultural significance, faces sustainability challenges, particularly for migratory species. In Poland, the calibration of annual harvest ceilings (quotas) relative to realized harvest and current abundance is debated. This study: (i) examined the Słupsk Hunting District by comparing district annual quotas (plans) with realized harvest, (ii) examined alignment between nationwide mid-winter (January) goose counts and season-long district harvest totals (Sep–Jan), and (iii) surveyed hunter demographics and preferences. Results showed significant discrepancies, with realized harvest totals well below planned levels (median = 11%). Goose abundance correlated moderately with harvests ($r = 0.647$, $p < 0.0001$), though phenological (mid-winter vs season-long) and effort mismatches limit interpretations. Among the hunters surveyed, more than one-third were over 45 years of age (36.2%). Most of these hunters chiefly targeted ducks (*ca*. 80% of respondents) and, to a lesser extent, geese (*ca*. 40%). These findings highlight that the maximum set quotas (ceilings) often exceed locally attainable harvest and emphasize the need for standardized monitoring, transparent quota recalibration and adaptive harvest strategies, and policy reforms to align hunting practices with ecological realities (current abundance and seasonal availability under observed effort), ensuring viable and sustainable wildlife management in Poland.

1. Introduction

Bird hunting has deep historical roots and today operates as a regulated practice, having shifted from subsistence to structured management (Grzegorczyk *et al*. 2024, Hill 1982). Two motives frame avian take: harvest—voluntary removal for food or recreation—and culling—targeted removals for population control or disease mitigation (MacDonald 2007, Duffy & St John 2013, Buss 2015, Gawin *et al*. 2015, Kamieniarz *et al*. 2020). Hunting delivers socioeconomic benefits and recreation and can foster stewardship (Lindsey *et al*. 2007, Hansen *et al*. 2012, Dai & Hu 2017, Shephard *et al*. 2024), yet remains contested for ecological and ethical reasons, especially where management is weak (Mitrus & Zbyryt 2015, Barca *et al*. 2016, Alba-Patiño *et al*. 2024). This tension underscores the need for balanced policies that reconcile economic gains, cultural values, and environmental sustainability (Madden & Sage 2020, Madden *et al*. 2023).

In Poland, the Hunting Law (October 13, 1995) governs game management. Each year, district hunting plans set harvest ceilings (quotas) prepared by lessees/managers, reviewed by local authorities and the agricultural chamber, and approved by the forest district manager with the Polish Hunting Association: park directors co-review plans for bordering districts. Migratory game birds are exempt from inventories (Article 8a), so their quotas rely on monitoring evidence rather than local counts. We treat quotas as ceilings, not targets, and evaluate their alignment with realized harvest and abundance. Game is classified as large or small (birds). Under the Regulation of March 11 2005, 13 bird species are huntable. The International Ornithological Congress (IOC) World Bird List and the North American Classification Committee (NACC) of the American Ornithological Society (AOS) recognize a split of the former Bean Goose *Anser fabalis* into *A. fabalis* (Taiga Bean Goose) and *A. serrirostris* (Tundra Bean Goose), a change not yet reflected in Polish law. Removals of invasive alien species (IAS)—*e.g.*, Canada Goose (*Branta canadensis*) under the Act on Alien Species (2021)—are authorized as culls and fall outside game harvest quotas.

Effective management of migratory game birds requires flyway-scale coordination, because populations cross multiple jurisdictions with differing rules and monitoring (Adams *et al*. 2014, Gallo-Cajiao *et al*. 2020). Along these routes, cumulative pressures—notably habitat loss and multi-country harvest—can destabilize populations (Sanderson *et al*. 2006, Newton 2004, Raine *et al*. 2015, Buchan *et al*. 2022). Trends diverge: Bean Goose (*Anser fabalis s.l.*) has declined, whereas Greylag Goose (*Anser anser*) and other residents have increased in parts of Europe (BirdLife International 2024). Yet species- and unit-specific abundance data are often sparse or inconsistent, complicating quota setting and risking misalignment between ceilings and population dynamics. We therefore ask whether legally prescribed annual harvest ceilings (quotas) align with ecological realities: (a) current abundance and trends, (b) residency–migratory phenology (including the September–January season vs. winter peaks), and (c) availability as reflected by realized harvest.

We pursue three objectives. First, we compared planned quotas with realized harvest in the Słupsk Hunting District (*ca*. 7,812 km²) (107 hunting subdistricts) for the 13 legally huntable bird species across three seasons (2017/18–2019/20). We quantified alignment as harvest efficiency and predicted higher and less variable efficiency for residents than for migrants, as well as a positive association between interannual quota changes and abundance indices. Second, to place quotas and harvest in the context of independent abundance evidence, we assessed alignment between the season-long district goose harvest (September–January) and the nationwide mid-winter (January) Wintering Water Bird Survey (MZPW) indices for geese across 43 hunting districts (including Słupsk Hunting District). We expected a positive but moderate association owing to phenological and effort mismatches. Removals of Canada Goose and other IAS are managed as culls outside district game quotas and are excluded from our analyses. Lastly, we explored hunter-level correlates using a nationwide anonymous survey (n = 47) capturing age, experience, effort, and species preferences. We expected greater per-capita harvest with increasing experience/specialization. These data provide context rather than calibration for district-level outcomes.

2. Materials and methods

2.1. Planned *vs.* harvested game birds

To examine the functional aspect of hunting (*i.e.*, how planning aligns with realized outcomes), we utilized datasets encompassing each of the thirteen species listed on the Polish game species list (Regulation of the Minister of the Environment, 11 March 2005), across three hunting seasons (2017/2018; 2018/2019; 2019/2020), subdivided by hunting subdistricts. Data were collected from the Słupsk Hunting District (Fig. 1). The Hazel Grouse (*Tetrastes bonasia*) was omitted, as there was no planned or actual harvest recorded for this species. It should be emphasized that these are confidential data, not commonly disclosed. An analysis was conducted on 107 hunting subdistricts in the Słupsk Hunting District (part of the Pomeranian and West Pomeranian voivodeships) comparing the established plan (annual harvest ceiling) for acquiring game birds with the execution of this plan (realized harvest). "Hunting district" refers to the administrative unit leased/managed for hunting, whereas "hunting subdistricts" are the district's internal planning/reporting units (n = 107 in Słupsk). For analysis, we extracted per-species plan (ceiling) and realized harvest totals for each season. It was essential to know how many birds of each species were planned for harvest and how many were harvested. Here, "plan" denotes the district's annual harvest ceiling (quota) as set in the approved district plan (prepared by the lessee/manager), while "execution" means the recorded harvest for that season.

To determine if there is a statistically significant difference between the planned and executed harvest of birds within individual species in separate hunting seasons, a chi-square test of independence was used. To test whether realized harvest deviated from the plan at the species × season level, we used an exact one-sample Poisson test, treating the plan as the expected mean under a Poisson model for counts, p-values by species and season are reported in Table 1. The analyses were conducted using the R statistical software, (version 4.3.1; R Core Team 2023), and figures were produced with ggplot2 (version 3.4.4; Wickham 2016).

2.2. Geese abundance in comparison with actual harvest

Data on the number of counted geese from 2011 to 2018 were obtained from the MZPW, which is a part of the official State Environmental Monitoring. The MZPW monitors the abundance of wintering birds in Poland, including geese:

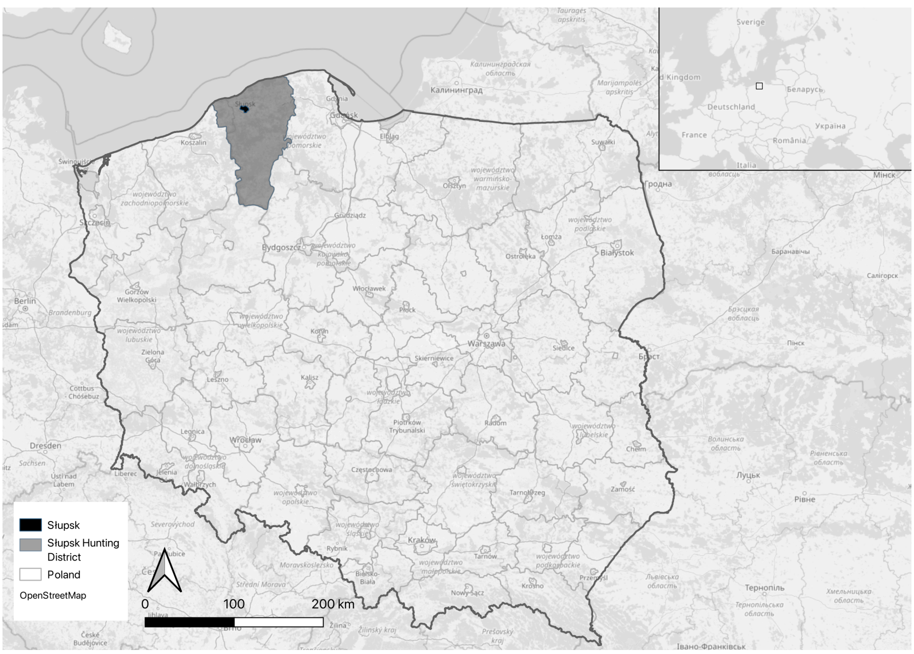

Fig. 1. Location of the Słupsk Hunting District (grey) within Poland in Europe.

Greylag Goose, Greater White-fronted Goose (*Anser albifrons*), Tundra Bean Goose, and Taiga Bean Goose. In cases where identifying the species is problematic, the geese are categorized into groups: unspecified goose, Taiga/Tundra Bean Goose, and Taiga/Tundra/White-fronted Goose. The MZPW counts are conducted mid-winter (January) at representative wintering sites (major lakes and reservoirs). In this study we use these January indices as an abundance backdrop to test alignment with harvest, we do not interpret them as denominators for a harvest rate. Season-long goose harvest totals for the same hunting districts (without species breakdown) were extracted from Hunting Report Data (*e.g.*, 2018). The goose hunting season runs from September 1st to December 21st across Poland, and until January 15th in the regions of Greater Poland, Lower Silesia, and West Pomerania (Regulation of the Minister of the Environment, 16 March 2005). For the present analysis, all counted geese were pooled in the same way as all harvested geese, while Canada Goose removals are treated separately as IAS culls.

Data from the MZPW (mid-winter) were mapped onto the administrative boundaries of Poland's hunting districts using geographic information system software (QGIS 3.16.4; QGIS Development Team 2020) to estimate goose abundances within each district. This allowed for a within-district comparison between the season-long (September–January) goose harvest totals (extracted from Hunting Report Data) and the mid-winter MZPW indices. To avoid erroneous results, only districts with MZPW count sites were included in the analysis. Geese are mobile and may forage in agricultural fields or other habitats away from their roosting sites, which could lead to some spatial mismatches between the locations of counted and harvested geese. However, the average area utilized by geese for roosting and foraging (*ca*. 10 km² (Boos *et al*. 2019)) is considerably smaller than the average size of a hunting district (*ca*. 6,400 km²), and districts often encompass diverse habitats such as waterbodies and adjacent farmlands. Consequently, spatial mismatches are much more likely to occur within the same district than between districts. Data analysis conducted using the R statistical software (version 4.3.1; R Core Team 2023), comprised a Pearson correlation to quantify the association between the numbers of counted and harvest geese.

This subsection concerns geese only. In the MZPW section we pool only game geese at the mid-winter index level (January), without separating residents *vs.* migrants at this data scale. We visualized district–year harvest versus mid-winter counts with a scatterplot including an ordinary least squares (OLS) fit with 95% confidence interval (CI).

2.3. Age structure and hunting preferences

The first step was to obtain reliable information on: (i) the age structure of the hunting community, (ii) the frequency of bird hunting, (iii) the species composition of the harvest, and (iv) hunters' opinions on bird hunting as a management/conservation tool. For this, we employed a mixed-mode questionnaire approach (online survey and paper forms) to reach respondents nationwide, including remote areas. All survey participants provided prior informed consent. Because these topics are sensitive and respondents may fear their data being used against them (public criticism of hunting, anti-hunter sentiment), which typically limits sample sizes (see Kupren & Hakuć-Błażowska 2021), participation was voluntary and anonymous. The study was not designed to be statistically representative of all Polish hunters and is descriptive/exploratory in scope. The questionnaire comprised 7 closed questions, 2 of which allowed multiple selections (the questionnaire is provided in the online supplementary material). In total, we obtained 47 complete responses from hunters across different districts. Associations between hunting experience (years since obtaining a hunting license) and the number of bird hunts (self-reported number of bird-hunting outings per season), and between age and hunting activity, were tested using Pearson's correlation.

3. Results

3.1. Planned vs. harvested game birds

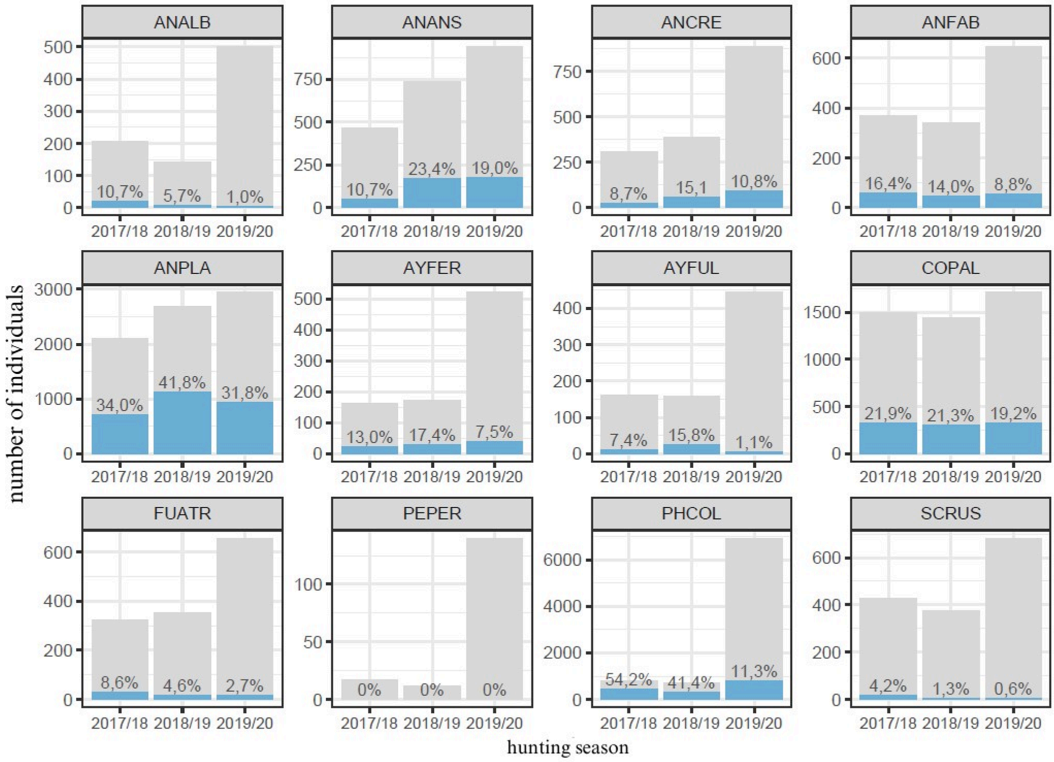

Fig. 2. Plan (in grey) and execution (in blue) of bird harvest in the Słupsk Hunting District during the studied hunting seasons 2017/18 – 2019/20. Each of the panel presents different species: ANALB - White-fronted Goose (*Anser albifrons*); ANANS - Greylag Goose (*Anser anser*); ANCRE - Teal (*Anas crecca*), ANFAB - Bean Goose (*Anser fabalis*); ANPLA - Mallard (*Anas platyrhynchos*), AYFER - Common Pochard (*Aythya ferina*); AYFUL - Tufted Duck (*Aythya fuligula*); COPAL - Wood Pigeon (*Columba palumbus*); FUATR - Eurasian Coot (*Fulica atra*); PEPER - Partridge (*Pedrix pedrix*); PHCOL - Pheasant (*Phasianus colchicus*); SCRUS - Woodcock (*Scolopax rusticola*).

For almost all bird species (except Wood Pigeon and Partridge) there were statistically significant differences between the planned and realized harvest across hunting seasons. Only Mallard showed a relatively high harvest in relation to quotas, with the highest harvest efficiency in the 2018/2019 season (41.84%). Moreover, this is the only species for which such an increase was noted, while a downward trend is observed for other species, with partridges not being harvested at all. For example, for the White-fronted Goose harvest efficiency dropped from 10.68% in the 2017/2018 season to just 1.00% in the 2019/2020 season. A similar trend is evident for species such as the Bean Goose, Pochard, Tufted Duck, Coot and Woodcock, which may indicate increasing difficulties in achieving the quotas or changes in the populations of these species. The median harvest efficiency (11 %) shows that half of the quotas were fulfilled at one-tenth or less of their ceiling, underscoring a systemic overestimation of quotas. Across the three seasons, realized harvest was substantially lower than the annual plans for most species (Table 1). The graphical visualization of the dynamics of acquisition in the studied hunting periods is presented in Fig. 2, for each species separately.

3.2. Geese abundance in comparison with actual harvest

The results indicate that the average number of counted geese was 4,422 while the average number of harvested geese was 301. The highest number of geese was recorded in the Wrocław

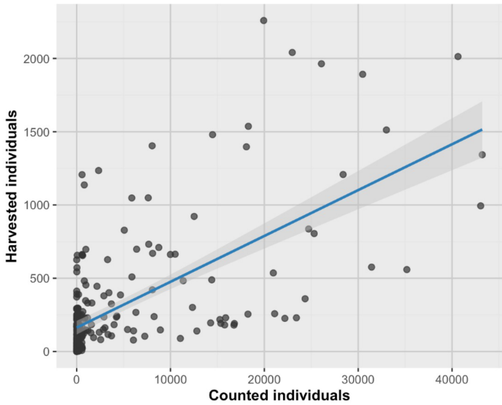

Fig. 3. Relationship between counted and harvested geese at the district level. Grey area represents 95% CI of the Ordinary Least Squares (OLS) regression.

Hunting District in 2013, where 43,223 individuals were counted. In the same district, the realized harvest was 1,343 individuals, representing 3.11% of the counted geese. The highest harvest was recorded in the Szczecin District in 2011, where 2,259 individuals were harvested. In the same year, the number of counted geese in there was 19,932, thus 11.33% of the counted geese were harvested.

We found a significant correlation between the number of geese counted and the realized harvest, with a correlation coefficient of 0.647 ($p < 0.0001$). The R^2 value was 0.419, indicating that counts explained 41.9% of the variance in harvest. The F-statistic value was 162.4, indicating statistical significance of the model, while the estimated slope was 0.0313. At the district–year scale, season-long goose harvest totals increased with mid-winter (January) MZPW counts within the same district boundaries (Fig. 3). Each point represents one district–year. An ordinary least-squares fit (solid line, 95% CI) indicated a positive association (Pearson $r = 0.647$, $R^2 = 0.419$, $p < 0.0001$; slope > 0), with substantial among-district/year variation. Some district–years show comparatively high harvest relative to their January counts, plausibly reflecting temporal-window mismatches between the mid-winter index and season-long harvest, differences in effort or access.

3.3. Age structure and hunting preferences

Among the surveyed hunters, the largest share is represented by individuals over the age of 45, accounting for 36.17% of the sample. They are followed by those aged 36 to 45 years, who make up 31.91%, and hunters aged 27 to 35 years, comprising 25.53%. The least numerous groups include individuals aged 18 to 26 years, representing only 6.38% of the respondents. We found no significant correlation between the experience of the hunter (years since obtaining a hunting license), age and the number of bird-hunting outings per season hunts ($r = 0.238$, $N = 47$, $P = 0.107$ and $r = 0.073$, $N = 47$, $P = 0.628$, respectively).

Out of 47 hunters: 79.56% harvested ducks, 40.43% harvested geese, 17.02% Wood Pigeons, 36.17% harvested Pheasants. The other species—Partridges, Hazel Grouse, Coots and Woodcocks—were taken only sporadically or not at all, together accounting for just 4.3% of respondents (never more than one hunter per species).

Regarding the motivations of hunting: 46.81% participate in bird hunting for consumption reasons, 17.02% harvest birds due to hunting damage, 14.89% did it for sports and recreational purposes. It was rare for a respondent to admit hunting without giving a reason, and some hunters left the question unanswered.

When asked about reducing the procurement plan, the overwhelming majority (70.2%) responded that the plan should not be reduced for any species as it does not pose a threat to bird populations. Roughly 12.8% of the hunters want to cut back the take of the Partridge, Hazel Grouse, Woodcock and Coot. Seventeen percent voice assorted concerns (unspecified views, fear of population declines). All respondents believe that hunting for birds should not be ceased.

These descriptive survey summaries provide context on who hunts and what is targeted, they do not calibrate Słupsk outcomes and are interpreted cautiously in the Discussion.

4. Discussion

The analysis of bird harvest data in the Słupsk

Table 1. Planned (n) and harvested (N) individuals of respective game bird species in the Słupsk Hunting District across three hunting seasons (2017/2018–2019/2020), with corresponding harvest efficiency (%) and statistical comparison. P-values in bold indicate statistically significant departures of realized harvest from the planned quota. For Wood Pigeon, the p-value is not bold because the pooled test was not significant (p = 0.142).

	Hunting season									
	2017/2018			2018/2019			2019/2020			
	Plan	Harvested		Plan	Harvested		Plan	Harvested		
Species	n	N	%	n	N	%	n	N	%	p[a]
W-F Goose[b]	206	22	10.68	141	8	5.67	501	5	1.00	**< 0.001**
Greylag Goose	469	50	10.66	734	172	23.43	941	179	19.02	**< 0.001**
Teal	310	27	8.71	390	59	15.13	887	96	10.82	**0.020**
Bean Goose	371	61	16.44	343	48	13.99	647	57	8.81	**0.001**
Mallard	2109	716	33.95	2679	1121	41.84	2943	937	31.84	**< 0.001**
Pochard	161	21	13.04	172	30	17.44	521	39	7.49	**0.001**
Tufted Duck	162	12	7.41	158	25	15.82	444	5	1.13	**< 0.001**
Wood Pigeon	1496	328	21.93	1445	308	21.31	1710	329	19.24	0.142
Eurasian Coot	325	28	8.62	351	16	4.56	656	18	2.74	**< 0.001**
Partridge	17	0	0	12	0	0	140	0	0	-
Pheasant	815	442	54.23	723	299	41.36	6925	781	11.28	**< 0.001**
Woodcock	427	18	4.22	377	5	1.33	682	4	0.59	**< 0.001**

[a]Test of equality of proportions without continuity correction, for the total counts across all hunting seasons.

[b]White-fronted Goose

Hunting District shows large discrepancies between annual quotas and realized harvests. Median harvest efficiency was *ca*. 11% across seasons. Across species, we observed very low realized-harvest ratios. As we cannot independently audit the validity of the harvest reporting, we analyzed the data as provided, assuming that managers of the hunting districts fulfilled statutory reporting obligations. Accordingly, we treat the low harvested values as credible and reflective of actual take (*e.g.*, Teal: 27 *vs.* 310 [8.7%], Table 1). This pattern mirrors broader challenges in managing migratory bird populations, a critical issue both in Poland—where 10 of 13 game bird species are migratory—and globally along flyways like the East Atlantic Flyway. Declining Bean Goose populations and rising Greylag Goose numbers, as reported by BirdLife International (2024), underscore the urgency of adaptive, cross-border management. Even resident species are affected: the planned pheasant quota jumped from 723 birds in 2018/2019 to 6,925 in 2019/2020, whereas the actual harvest plunged from 41.36 % to 11.28 %, indicating abrupt shifts in abundance or accessibility. These fluctuations are best explained by management practices for this species—large numbers of pen-reared pheasants are released into hunting grounds (Flis 2012, Madden *et al*. 2018). By contrast, Mallard are not released in

Poland, so the recorded totals reflect wild birds. Even without releases, harvest efficiency for Mallard was relatively high, peaking at 41.84% in 2018/2019.

In Poland, the Hunting Law's omission of mandatory population inventories, coupled with difficulties distinguishing resident breeders from transient migrants, results in overestimated quotas that function as theoretical ceilings rather than achievable goals. The consistent under-fulfilment of quotas (low harvest efficiency) suggests that current ceilings are set too high relative to attainable harvest. Because the rules and inputs used to set ceilings are not publicly available, we cannot discuss and propose revisions the method. To ensure sustainability and transparency, such methodology should be made fully public and open to scientific scrutiny. It should utilize up-to-date abundance indices (MZPW) and—when available—standardized hunting-effort metrics. Globally, the lack of reliable population estimates makes it difficult to manage hunting sustainably, numerous studies show that quotas and other regulations are often set without reference to the true size and trend of the targeted bird populations. (Gallo-Cajiao *et al*. 2020). The moderate correlation between geese monitoring data and harvests ($r = 0.647$, $p < 0.0001$) suggests monitoring informs quotas to some extent, yet the low R^2 (0.419) points to unaccounted variables—hunter behavior, habitat shifts, or weather patterns—consistent with global findings where socioeconomic dynamics often override ecological intent (Raine *et al*. 2015).

Methodological constraints further complicate interpretation. We treat mid-winter (January) MZPW counts as an abundance backdrop to test alignment with season-long harvest and quotas. We do not use January counts as denominators for a population harvest rate. The hunter survey's limited sample size (n = 47) restricts its generalizability across Poland's diverse hunting community, and the lack of standardized effort data limits inference. The apparent inconsistency—stable harvest totals (228–241 geese) despite large variation in mid-winter counts (250–4,228)—is consistent with a decoupling of harvest from abundance under low or variable effort and access constraints, accordingly, weak quota–abundance alignment may arise even if ceilings respond to monitoring. Without effort metrics (*e.g.*, hunter-days), we cannot distinguish between effort-driven and abundance-driven variation in the harvest. These gaps expose vulnerabilities in current practices, necessitating robust solutions. A practical first step is to implement standardized, ground-based counts conducted on the same dates each month at fixed sites (like the United Kingdom Wetland Bird Survey approach), which would yield comparable indices across districts and reduce turnover/phenology bias. As a minimum data standard, districts should annually publish quotas, realized harvest, and basic effort metrics (*e.g*., hunter-days), enabling routine, independent evaluation of quota calibration. Remote-sensing approaches (*e.g*., GPS tracking, drones; Bouten *et al*. 2018) can then complement these counts by quantifying movements and improving detection in inaccessible habitats. Rather than implying overharvest, a pragmatic next step is to adopt flexible harvest limits that are recalibrated annually to current abundance and—when available—standardized effort, akin to Norway's Willow Ptarmigan system (Aanes *et al*. 2002), to improve calibration and reduce both over- and under-harvest risk. This recommendation aims at better calibration and transparency rather than demonstrating current overharvest under the analyzed conditions. Given our data limitations (no standardized effort metrics; mid-winter counts; pooled geese), we do not estimate population harvest rates or sustainability and frame this recommendation as a process improvement, not evidence of overharvest. The aging hunter demographic (36.17% over 45, 6.38% aged 18–26) signals a need for targeted education to recruit and train younger hunters in sustainable practices, a pressing concern echoed in Europe and North America (Dzięciołowski 2013, Van der Merwe & Saayman 2019). Policy reforms, such as amending the Hunting Law to mandate inventories, enforce quota transparency, and incentivize compliance via subsidies—drawing from Scandinavian successes (Dressel *et al*. 2021)—could bridge ecological and practical divides. Finally, integrating citizen science, where hunters report sightings via mobile apps (Nokelainen *et al*. 2024, Zanet *et al*. 2024), could further bolster data granularity, aligning Poland's strategies with innovative global models (Sullivan *et al*. 2009). These steps collectively aim to harmonize hunting with conservation, ensuring sustainable migratory bird management.

Epäsuhta suunniteltujen ja toteutuneiden saaliiden välillä: metsästäjien demografian, saalistietojen ja vesilintujen seurannan integrointi riistanhoidon tueksi Puolassa

Lintujen metsästys, jolla on vahva historiallinen ja kulttuurinen merkitys, kohtaa nykyisin merkittäviä kestävyyshaasteita, erityisesti muuttolintulajien osalta. Puolassa keskustellaan siitä, miten vuotuiset saaliskiintiöt tulisi säätää vastaamaan toteutunutta saalista ja lajien nykyistä runsautta. Tässä tutkimuksessa: (i) tarkasteltiin Słupskin metsästysaluetta vertaamalla alueen vuotuisia kiintiöitä (suunnitelmia) toteutuneeseen saaliiseen, (ii) arvioitiin valtakunnallisten keskitalven (tammikuu) hanhilaskentojen ja koko metsästyskauden (syyskuu–tammikuu) alueellisten saalistietojen välistä vastaavuutta, ja (iii) kartoitettiin metsästäjien demografiaa ja preferenssejä. Tulokset osoittivat merkittäviä eroja: toteutuneet saaliit jäivät selvästi suunniteltujen tasojen alapuolelle (mediaani = 11 %). Hanhien runsaus korreloi kohtalaisesti saaliiden kanssa ($r = 0{,}647$, $p < 0{,}0001$), vaikka fenologiset (keskitalvi vs. koko kausi) ja metsästyspanostuksen epäsuhtaisuudet rajoittavat tulkintoja. Kyselyyn vastanneista metsästäjistä yli kolmannes oli yli 45-vuotiaita (36,2 %). Suurin osa näistä metsästäjistä keskittyi pääasiassa sorsiin (*n*. 80 % vastaajista) ja vähemmässä määrin hanhiin (*n*. 40 %). Havainnot osoittavat, että asetetut enimmäiskiintiöt ylittävät usein paikallisesti saavutettavissa olevan saaliin ja painottavat tarvetta standardoidulle seurannalle, läpinäkyvälle kiintiöiden uudelleenkalibroinnille ja sopeutuville saalisstrategioille sekä politiikkauudistuksille, jotta metsästyskäytännöt saadaan vastaamaan ekologisia realiteetteja (nykyinen runsaus ja kausittainen saatavuus suhteessa havaittuun metsästyspanostukseen), mikä varmistaa elinkelpoisen ja kestävän riistanhoidon Puolassa.

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Conflict of interest. The authors declare no conflicts of interest.

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Data availability. The datasets analyzed in the current study are available from the author on reasonable request.

Author contributions. All authors contributed to the creation of the manuscript. K. Piórkowska was responsible for data collection and original draft preparation. M. Szkudlarek reviewed and edited the manuscript draft. Ł. Jankowiak participated in data processing and analysis.

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Online supplementary material

Supplementary material available in the online version of the article includes the questionnaire given to the hunters.