Framework-date Extensions for Duck Hunting in the United States: Supplemental Assessment

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Executive Summary: The Senate Committee on Appropriations recently directed the U.S. Fish and Wildlife Service to conduct a study of hunting-season framework extensions on migratory waterfowl populations. This report is intended to fulfill that directive, and to supplement information prepared last year in response to a similar directive. Based on past experience in Iowa and Mississippi, extensions of duck-hunting seasons beyond the traditional framework dates of October 1 to January 20 tend to increase duck harvests, with the magnitude of the increase dependent on species. Nationwide extensions of duck-hunting seasons could have significant impacts on the frequency of years in which liberal hunting regulations could be offered, as well as increase the frequency of annual regulatory changes. Because the framework extension offered in the southern Mississippi Flyway this year included a 9-day season

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Background

Congress directed the USFWS Office of Migratory Bird Management to conduct a study of framework extensions no later than December 31, 1998 (Senate Committee on Appropriations Report 105-227); this deadline was subsequently extended to January 31, 1999. This report is intended to fulfill that Congressional directive and supplement information prepared last year in response to a similar directive (*Congressional Record,* Sep. 22, 1997, pg. H9018[15]).

Nature of this Assessment

A previous assessment provided by the USFWS (USFWS 1998) examined the change in duck harvests attributable to framework-date extensions in Iowa (1979-87, 1995) and in Mississippi (1979-84). Those results then were used to infer the effects of nationwide framework-date extensions on optimal harvest strategies for midcontinent mallards. For the purpose of this report, we used improved procedures to re-analyze historic data relative to the Iowa and Mississippi extensions, and then examined changes in mallard harvest strategies associated with a possible range of increases in the mean and variance of predicted harvest rates. The intent was to determine the sensitivity of regulatory strategies to framework extensions up to, and including, a *nationwide* extension of 10 days for both the earliest opening and latest closing dates. We also examined the potential effects on mallard harvests of the framework extension offered this year in the southern Mississippi Flyway. Finally, the National Flyway Council has asked the USFWS to evaluate the potential effects of extending framework dates by approximately five days; results of that assessment are also included in this report.

Effects of Extended Framework Dates on Mallard Harvests in Iowa and Mississippi

We estimated the effect of extending the framework dates in the treatment states in the treatment years using an extension of a multivariate time-series analysis. The analysis involved three steps: (1) a regression of the treatment state's harvests to estimate the possible increase in the average annual harvest due to the framework extension; (2) an analysis of the annual harvests to account for the data not being independent over time; and (3) a graphical multivariate regression model to account for the annual variation in harvests not attributable to the framework extension. We modeled the logarithms of the harvests because the variation in the harvests increases as the level of harvest increases, and because a change in the value of the logarithms can be interpreted as a proportional change.

First, we specified a regression using only the treatment state's harvests for a given species. We assumed that the harvest varies around its mean. Then, during the years the framework dates were extended, we tested how much the mean for the state harvest increased over years without the extension. The model was:

$$\log(h_{t,\,trt}) = c + \beta_{trt} + e_t$$

where t indexes years, $\log(h_{t,\,trt})$ is the logarithm of harvest in the treatment (*trt*) state, c is the overall mean, β_{trt} is the proportional change due to the framework extension, and e_t are the regression errors.

Second, we constructed a time-series analysis because the regression errors e_t are not independent. We examined correlations between regression errors and found that a simple first-order autoregressive model would account for dependence over time:

$$e_t = \phi e_{t-1} + a_t$$

where the year-specific error is related to some proportion (ϕ) of the previous-year error, plus an error term a_t.

Finally, we combined harvests from treatment and surrounding states into a multivariate analysis. In the above models, we assume that harvest varies around a mean, except for the effect (if any) of the framework extension. However, we know that many other factors affect variation in annual harvest. We do not know all the sources of this variation, but we can account for the variation by using harvest information from surrounding states. By examining the partial correlations (i.e., the correlations between states' harvest occurring in the same year, given all the other states in the model), we were able to determine the most appropriate non-treatment states to use for isolating the framework-extension effect from other sources of variation.

Some species had zero or trace harvest for some years. These values were either removed from the analysis by treating them as outliers or by adding a small value, 10, to all the harvest estimates. If these two analyses produced very different results, we disregarded the analysis for that species.

To summarize, this analysis accounted for possible increases in harvest due to the framework extension, and for annual variation in harvest not due to the extension by using surrounding states in a multivariate graphical model. This analysis has the following advantages over the previous attempt: (1) it accounts for lack of independence in harvest data over time; (2) it matches states' harvest for the same years, rather than averaging treatment and non-treatment years in treatment and control states (analogous to a paired *t*-test); and (3) it weights the effect of each surrounding state by its partial correlation coefficient, rather than assuming that each state reflects the annual variation in the harvest of the treatment state to the same degree.

The proportional changes in harvest attributable to the framework extensions in Iowa and Mississippi were not qualitatively different than those in our previous analyses (USFWS 1998), although the estimated magnitude of the effect changed for most species (note that the scale of β has changed from the first report such that β is now centered on zero rather than one). In Iowa, the framework extension appeared to increase ($P<0.02$) the annual harvests of six of the eight most important species in the bag (Table 1). In Mississippi, the magnitude of the estimated harvest increases tended to be lower than in Iowa, and were significant ($P<0.1$) only for mallards and gadwall. We note that the estimated increase in mallard harvest in Mississippi is considerably lower than in our previous analysis.

Table 1. Proportional changes in annual duck harvests (β) attributable to the framework extension in Iowa during 1979-87 and 1995.

Species	β	SE(β)	*z*	*P* (1-tailed)
Mallard	0.320	0.142	2.250	0.012
Blue-winged teal	0.948	0.194	4.893	0.000
Green-winged teal	0.358	0.153	2.344	0.010
Gadwall	-0.136	0.135	-1.006	0.843
Wigeon	0.267	0.127	2.098	0.018
Wood duck	0.277	0.119	2.317	0.010
Scaup	0.397	0.185	2.145	0.016
Ring-necked duck	0.113	0.095	1.193	0.116

Table 2. Proportional changes in annual duck harvests (β) attributable to the framework extension in Mississippi during 1979-84.

Species	β	SE(β)	*z*	*P* (1-tailed)
Mallard	0.180	0.113	1.590	0.056
Blue-winged teal	0.257	0.241	1.067	0.143
Green-winged teal	-0.378	0.221	-1.712	0.957
Gadwall	0.427	0.126	3.383	0.000
Wigeon[a]	0.149	0.181	0.825	0.205
Wood duck	0.133	0.155	0.857	0.200
Scaup[b]				
Ring-necked duck	-0.143	0.414	-0.334	0.631

[a] Zero harvests in some years handled by adding 10 to all harvest values.
[b] Zero harvests in some years prevented reliable estimates.

Potential Impacts of Nationwide Framework Extensions on the Regulation of Mallard Harvests

Empirical analysis.--We determined the expected increase in total harvest of midcontinent mallards associated with framework dates extending approximately 10 days earlier and 10 days later than permitted under current regulatory alternatives. We assumed all states that held their seasons as early or late as possible during the 1997-98 season would take advantage of extended framework dates if they were offered (USFWS 1998). In practice, some of these states might not take advantage of extended framework dates, or would use them only with some regulatory alternatives or in some zones, but we had no basis for predicting such scenarios. Therefore, our analysis represents a worst-case scenario in terms of large-scale impacts.

In those states opening around 20 September, we assumed that mallard harvest would increase by 32.0 percent (SE = 14.2) compared with the current framework date of approximately 1 October. For states closing around 31 January, we assumed that mallard harvest would increase by 18.0 percent (SE = 11.3) compared with the closing framework date of approximately 20 January. We assumed no change (SE = 0) in harvest from current levels in states not expected to use extended framework dates and in Canada. The overall increase in harvest of midcontinent mallards was calculated by averaging the predicted change in harvest for individual states, using the proportion of band recoveries of midcontinent mallards occurring in each state as weights. Band recoveries were adjusted for sources of variation in reporting rate (Nichols et al. 1995, C. T. Moore, unpub. data). The variance of the overall increase in harvest was estimated according to Goodman (1960, eq. 5). The predicted increase in harvest of midcontinent mallards associated with 10-day extensions of opening and closing dates was 23.1 percent (SE = 4.4).

Optimization/simulation study.--We computed optimal harvest strategies for midcontinent mallards using methods described by Johnson et al. (1997). We used an objective function to maximize long-term cumulative harvest, with a proportional devaluation of harvest when the size of the mallard population is expected to fall below the goal of the North American Waterfowl Management Plan. We also used the most current assessment of probabilities on four competing models of mallard population dynamics (Johnson 1998). We investigated the application of optimal strategies using Monte Carlo simulations, and evaluated expected performance using the mean of annual harvest and population size. We also tallied the frequency with which each of the four regulatory alternatives was used during the simulations, as well as the probability and magnitude of year-to-year regulatory changes.

We examined a range of possible harvest rates, bounded by those predicted under the current regulatory alternatives, and what might be realized under a nationwide extension of 10 days for both opening and closing dates in the moderate and liberal options. We also examined a range of harvest-rate variances from the current level of CV = 0.25 to CV = 1.0. For the purposes of this analysis, an increase in harvest-rate variance represents a decline in confidence regarding the ability to predict harvest rates associated with framework extensions. This decline in predictive ability reflects our uncertainty about whether the effects of extensions in Iowa and Mississippi are representative, and about what states would choose an extension if it were offered. We believe a two- to three-fold increase in harvest rate CV would be reasonable given our lack of experience with framework extensions.

Based on simulations of optimal harvest strategies, even small changes in harvest rate mean and variance can have significant impacts on regulatory strategies. With increases in mean harvest rate of the moderate and liberal alternatives, the expected frequency of liberal regulations declined (Fig. 1), while that of the moderate and restrictive alternatives increased (Figs. 2 and 3). The frequency of very restrictive regulations was not noticeably affected by increases in mean harvest rate (Fig. 4). The probability of year-to-year regulatory changes also increased with increased harvest-rate means, although the magnitude of annual changes was largely unaffected (Fig. 5). Results associated with increases in the variance of harvest rates were also consistent with more conservative harvest strategies. Although the frequency of liberal regulations was relatively insensitive to increased variances, the expected frequency of restrictive regulations increased dramatically, at the expense of the moderate alternative.

Interestingly, mean annual harvest and population size were not sensitive to increases in the mean harvest rate of the moderate and liberal options (Figs. 6 and 7). These results reflect the compensatory effect of the more conservative strategies associated with increases in harvest rate. Increases in the variance of harvest rates led to significant decreases in average harvest and increases in average population size, reflecting a dramatic increase in the frequency of restrictive regulations.

Potential Effects of the 1999 Framework Extension in the Southern Mississippi Flyway

Using historical data on mallard harvest and numbers of successful duck hunters (SDH) from 1970-1995, two models were developed to predict total seasonal mallard harvest for the southern Mississippi Flyway (States of Alabama, Arkansas, Kentucky, Louisiana, Mississippi, and Tennessee). The "harvest" model utilized information on mallard bag limits and hunting season length to predict mallard harvest per SDH for each day of the hunting season. These daily predictions were then summed to arrive at a predicted seasonal mallard harvest per SDH. The "hunter" model was developed to predict the number of SDH in a specific year under a specific set of hunting regulations (bag limit and season length). The predicted number of SDH was multiplied by the predicted seasonal harvest per SDH resulting in a predicted total mallard harvest for a specific year.

We then predicted seasonal mallard harvests for the current liberal (60 days) and moderate (45 days) regulatory alternatives (without framework extensions), and for those same alternatives that had been reduced by a specified number of days. The proportional reductions in seasonal mallard harvest are provided in Table 3. Based on the observed increase in mallard harvest during the 1979-84 framework extension in Mississippi (+18%), the framework extension offered in the southern Mississippi Flyway this year (which includes a 9-day reduction in season length) should not result in a significant change in mallard harvest. Under the moderate alternative, an 8-day reduction in season length appears sufficient to prevent an increase in mallard harvest.

Table 3. Predicted reductions in mallard harvest associated with reductions in season length under the liberal and moderate regulatory alternatives.

Regulatory alternative (days)	Reduction in days	Proportional reduction in harvest
Liberal (60)	10	0.1916
Liberal (60)	9	0.1736
Liberal (60)	8	0.1544
Moderate (45)	9	0.2128
Moderate (45)	8	0.1892
Moderate (45)	7	0.1642

The National Flyway Council Request

In an effort to resolve the debate over framework-date extensions, the National Flyway Council recently asked the USFWS to evaluate the potential effects of extending the earliest opening and latest closing dates by approximately five days (i.e., framework dates of September 26 to January 25). Unfortunately, we know of no empirical basis for estimating the changes in duck harvest, nor in optimal strategies for mallards, associated with these particular framework dates. Our only experiences with framework extensions in Iowa and Mississippi involve approximately ten days, and we have no means to estimate harvest effects for other increments of time. However, the effects of the five-day extension likely would fall within the range of effects we examined. Assuming a linear increase in mean harvest for each day framework dates are extended, and no change in our ability to predict harvests, and without any corresponding offset in season length, this option would have significant effects on the frequency of liberal seasons and regulations. The frequency of liberal regulations would decline from about 64 to 38 percent. The frequency of restrictive regulations would increase from 12 to 24 percent. The probability of year-to-year regulatory changes would increase from about 0.38 to 0.48. If we were to assume a reasonable loss of confidence in our ability to predict overall harvests (e.g., CV=0.50), the frequency of restrictive regulations would increase further to 38 percent.

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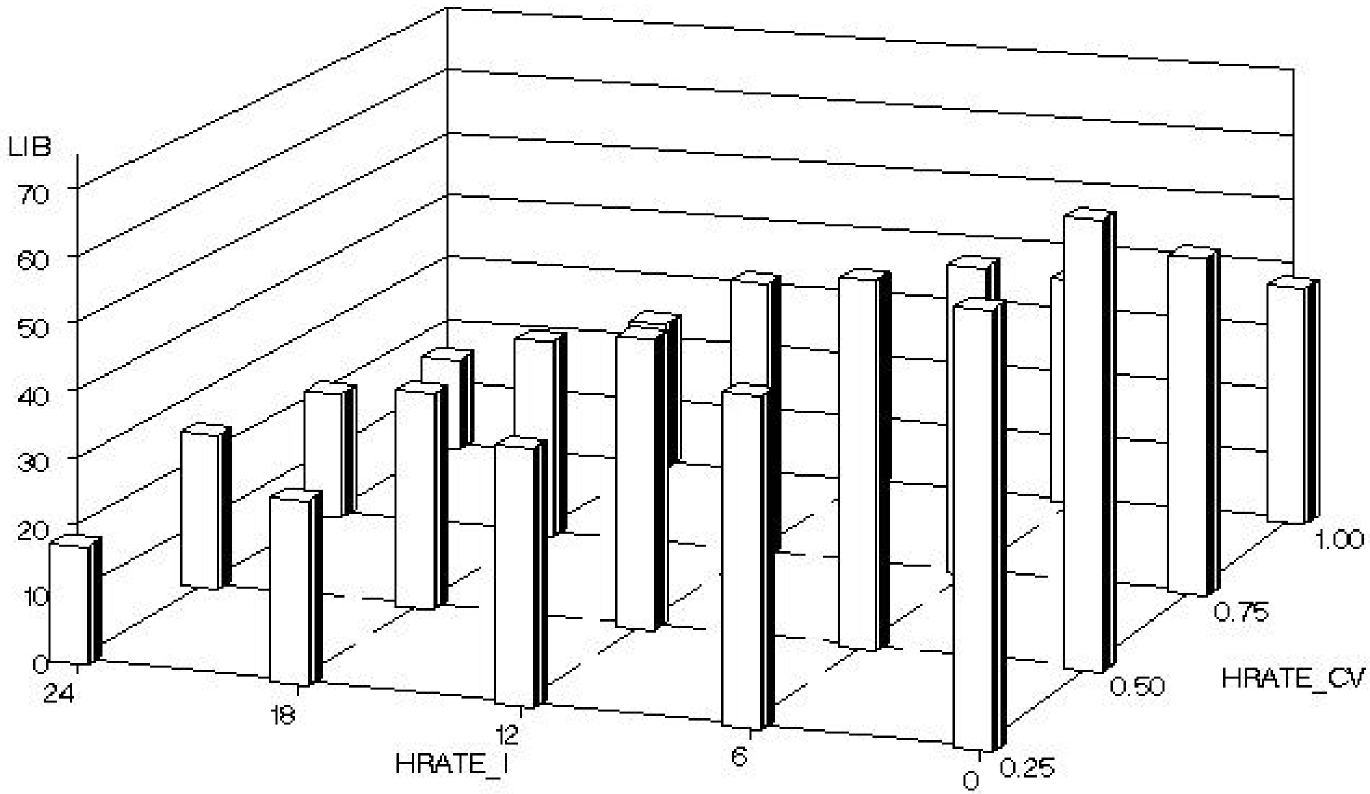

Fig. 1. Expected frequency (%) of liberal regulations (LIB) as a function of harvest rate CV (HRATE_CV) and percentage increases in harvest rate (HRATE_I) of the moderate and liberal alternatives.

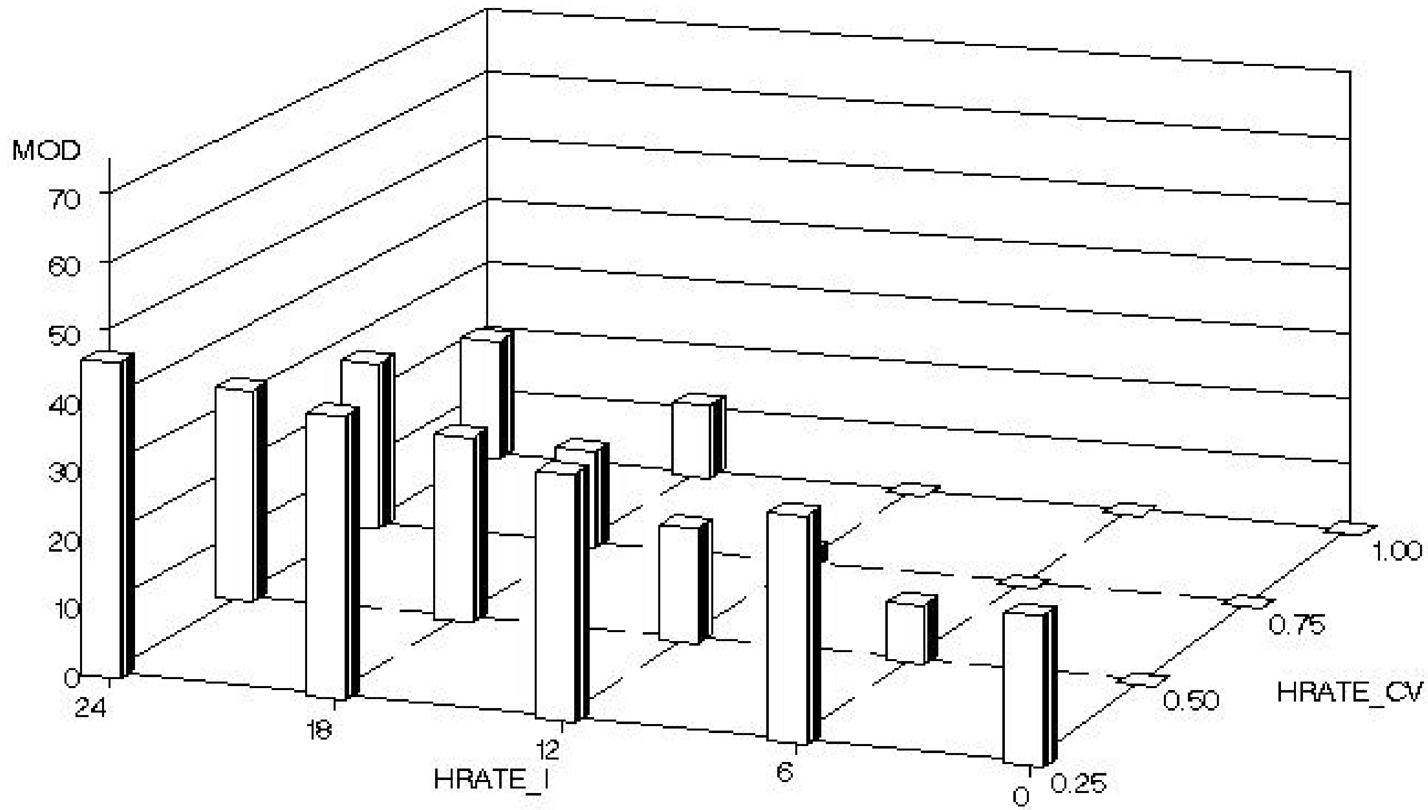

Fig. 2. Expected frequency (%) of moderate regulations (MOD) as a function of harvest rate CV (HRATE_CV) and percentage increases in harvest rate (HRATE_I) of the moderate and liberal alternatives.

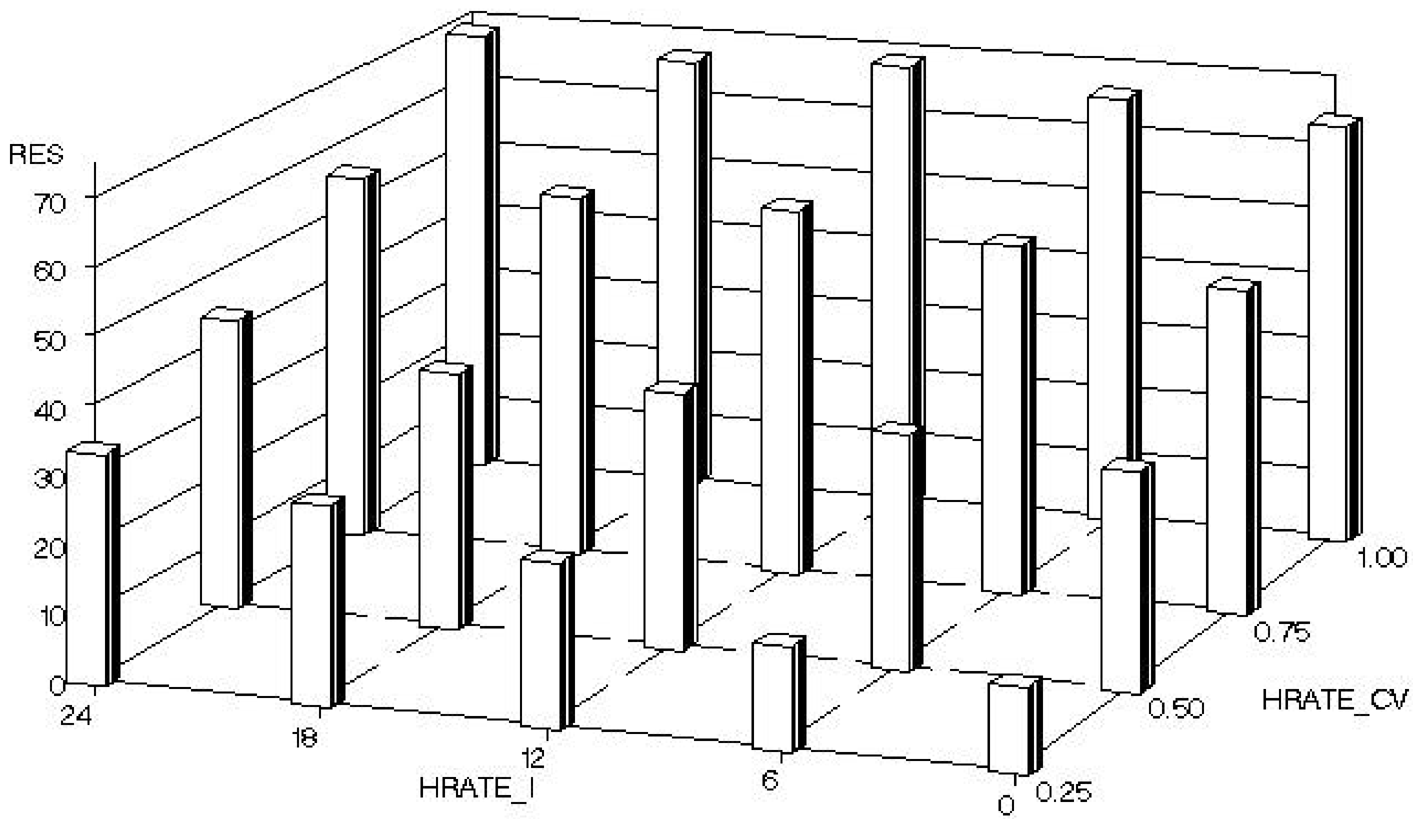

Fig. 3. Expected frequency (%) of restrictive regulations (RES) as a function of harvest rate CV (HRATE_CV) and percentage increases in harvest rate (HRATE_I) of the moderate and liberal alternatives.

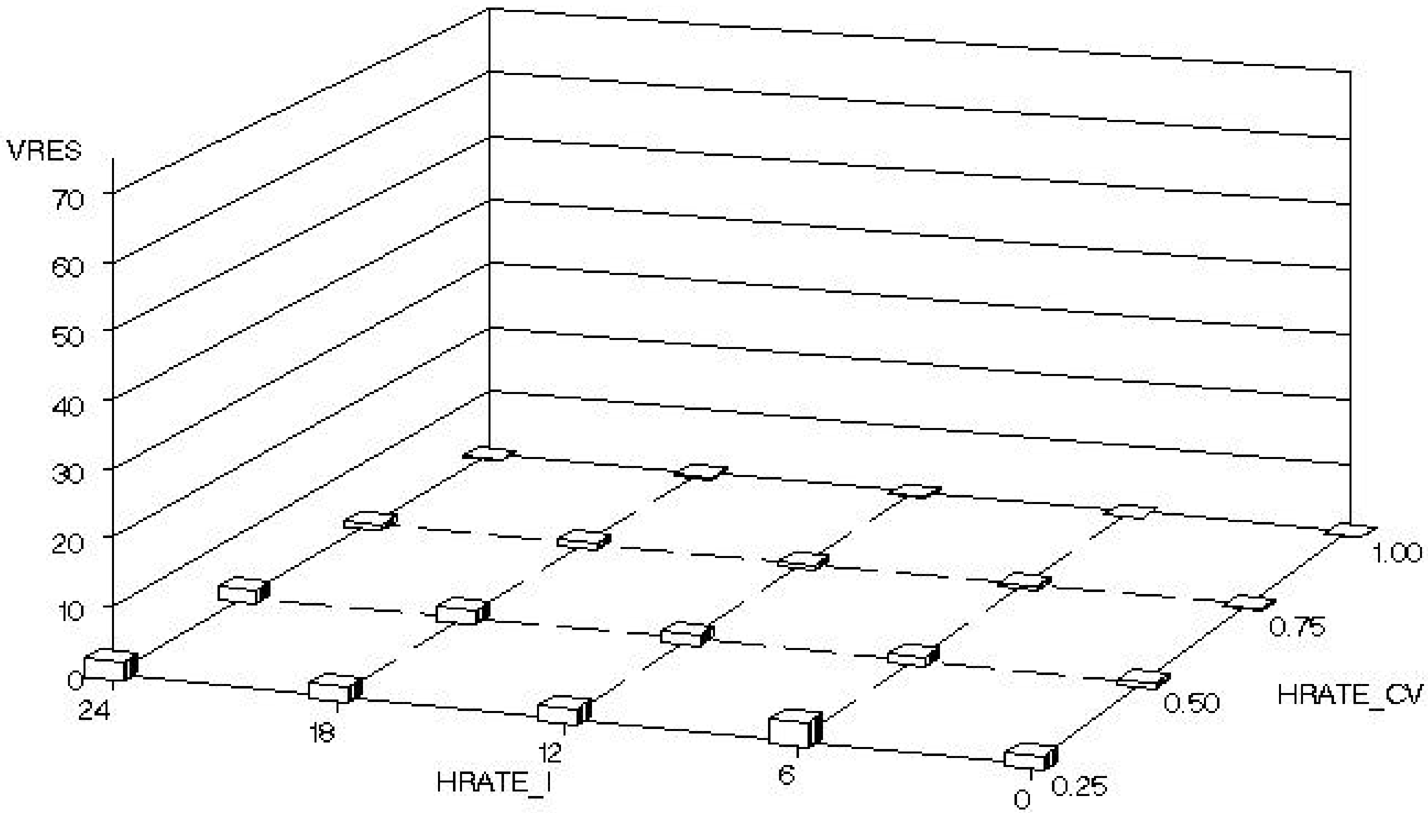

Fig. 4. Expected frequency (%) of very restrictive regulations (VRES) as a function of harvest rate CV (HRATE_CV) and percentage increases in harvest rate (HRATE_I) of the moderate and liberal alternatives.

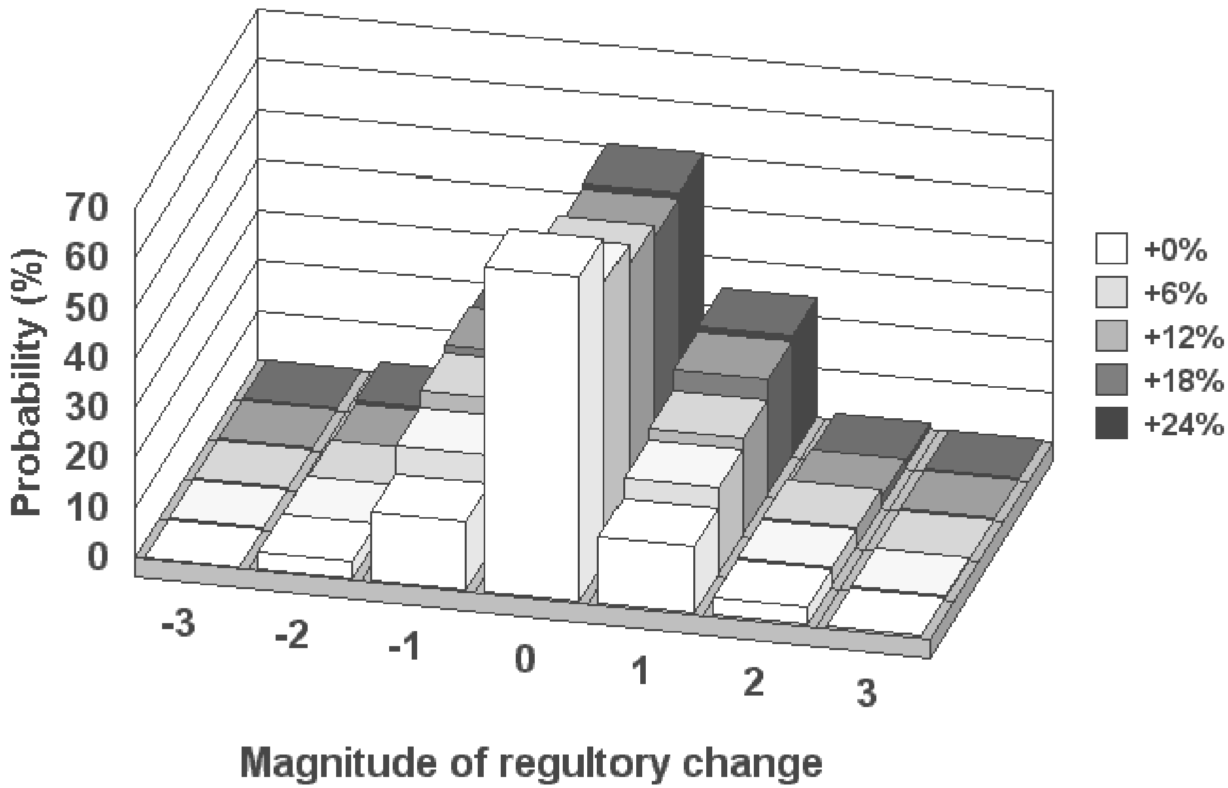

Fig. 5. Probability of year-to-year regulatory changes associated with increases in mean harvest rates of the moderate and liberal alternatives.

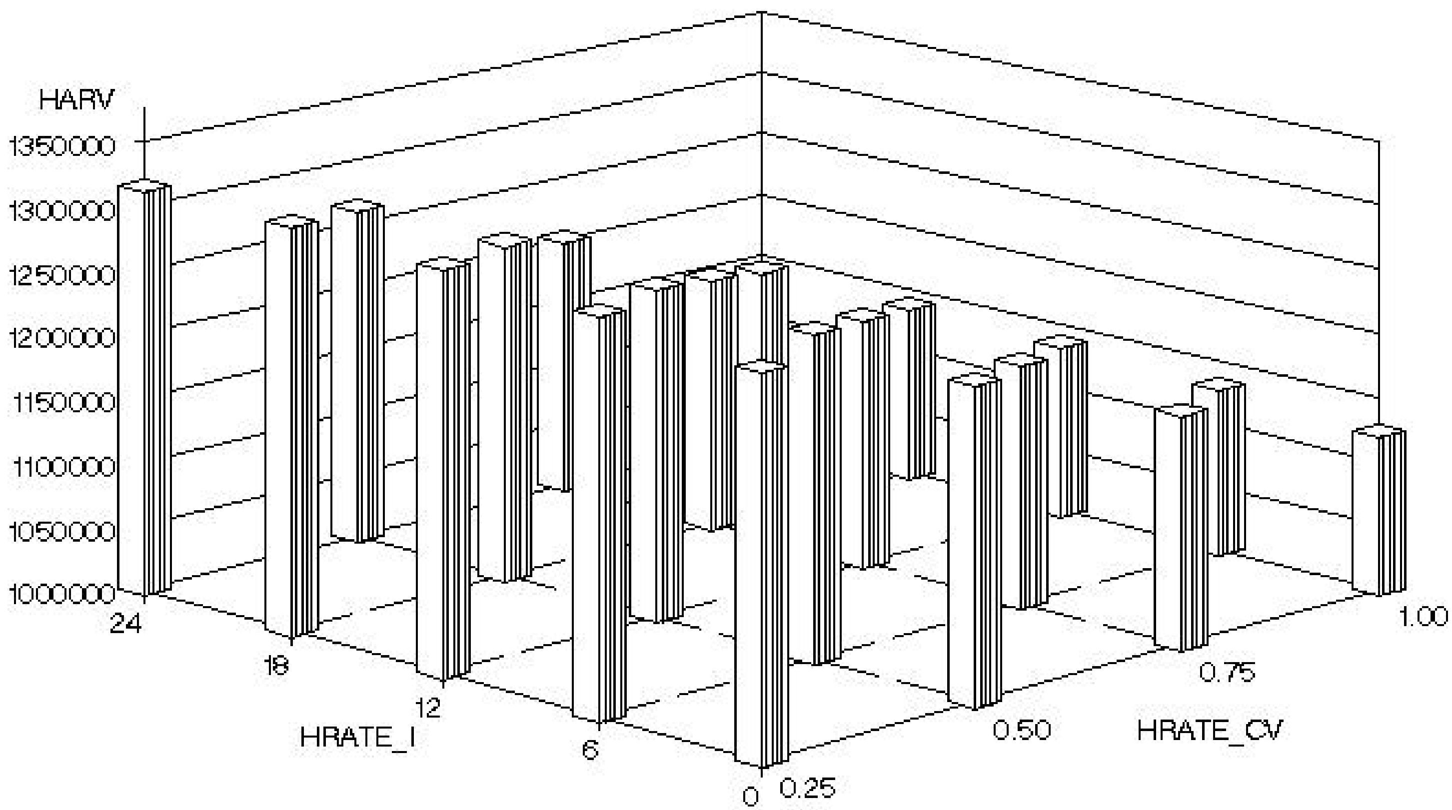

Fig. 6. Expected mean annual harvest as a function of harvest rate CV (HRATE_CV) and percentage increases in harvest rate (HRATE_I) of the moderate and liberal alternatives.

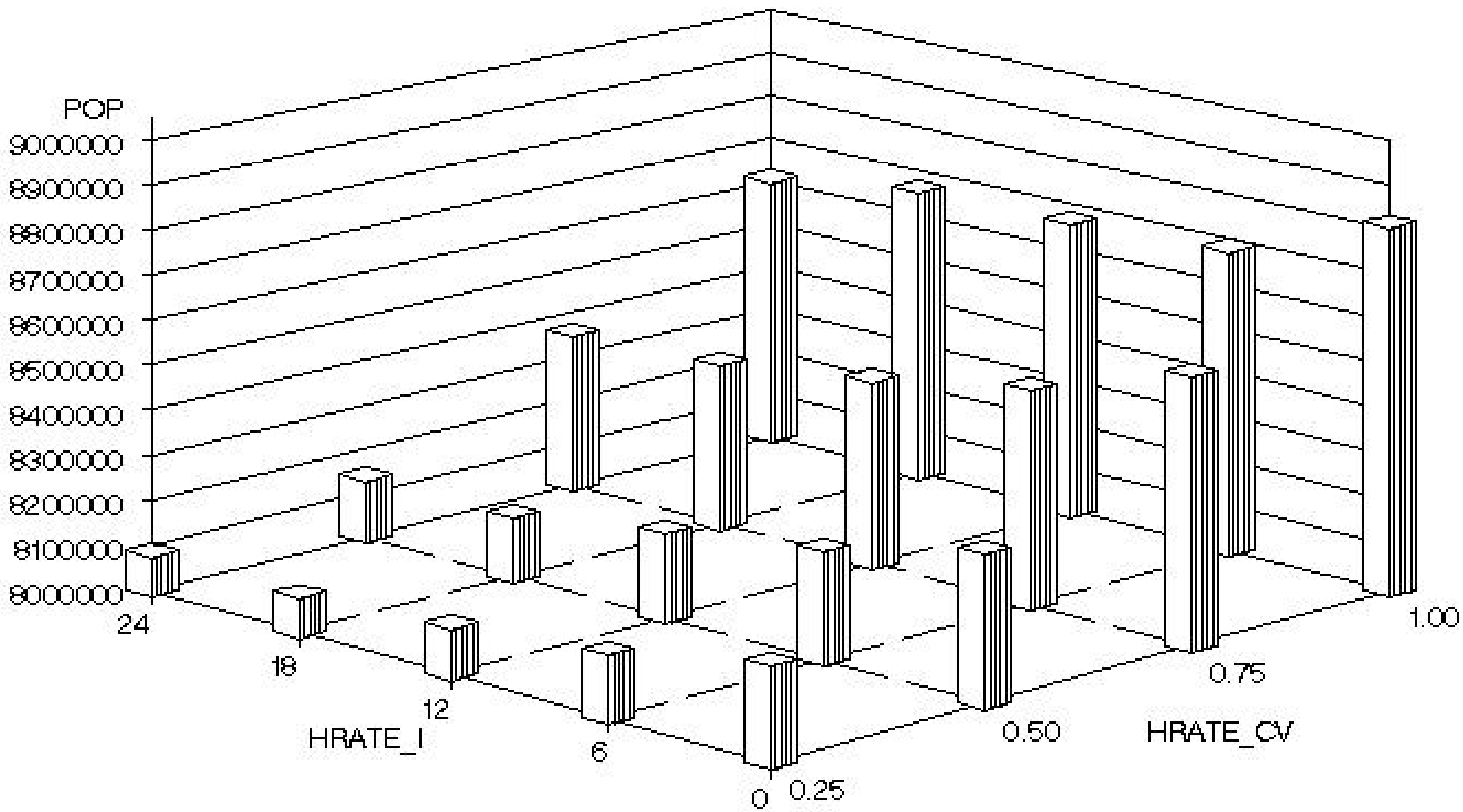

Fig. 7. Expected mean population size (POP) as a function of harvest rate CV (HRATE_CV) and percentage increases in harvest rate (HRATE_I) of the moderate and liberal alternatives.