Quantification of the relationship between Mallard nest initiation and temperature

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Introduction

Temperature plays an important role in determining the arrival of waterfowl and the beginning of nesting on the Canadian Prairies. Sowls (1955) suggested that below normal spring temperatures delay the beginning of the nesting season as long as 2 weeks. Corroboration of this claim for Mallard *Anas platyrhynchos* is found for south-eastern Saskatchewan (Stoudt 1971), southern Alberta (Keith 1961) and central Alberta (Smith 1971). This relationship is also applicable in other early nesting species, for example, Pintail *Anas acuta* (*op. cit.*, Yocom 1950) as well as Canada Geese *Branta canadensis* (Naylor & Hunt 1954; Yocom & Hanson 1960). Rapid and prolonged reduction of temperature has a negative effect on ovulation, on the number of nest initiation facilities the use of a production (Dane 1966; Dane & Pearson 1971).

This is a preliminary investigation into the relationship between peak nest initiation of Mallard and weather. Although the quality and quantity of nesting effort data was not sufficient to permit a powerful statistical test, the analysis allows us to reach some tentative conclusions. The quantification of the relationship between weather and the timing of nest initiation facilitates the use of a potential weather component in waterfowl production models such as those of Walters *et al.* (1974), Anderson (1975) and Brown *et al.* (1976).

Methods

Data on Mallard nest initiations on 4 study areas were obtained from annual progress reports or the literature. We determined a peak for nest initiation, defined as the week within which the maximum number of nest starts occurred. In general, the distributions of nest initiations were not flat and a peak could be determined, although with only weekly data available it was difficult to define confidently. There is therefore some error of measurement in the independent variable.

We have assumed that the observed peaks reflect the true nesting effort although we admit that a differential predation rate biased to the early period of nesting could occur. Further, we have assumed that the age distributions among areas were equal for all areas and for all years. The week of peak nest initiation was determined for 2 years for Delta, 1949 and 1950, (Sowls 1955); for 4 years for Roseneath, 1952 to 1955, and Kindersley, 1956 to 1959 (Dzubin & Gollop 1972) and 10 years for Redvers from 1953 to 1961 and 1963 (Stoudt 1954 to 1961 inclusive, and 1963). The statistic used for peak nest initiation was the number of days after April 1st to the mid point of the week of peak nest initiation.

April temperatures were obtained from daily weather bulletins and weekly weather summaries (Atmospheric Environment Branch, Dept. of Environment, Ottawa) for weather stations nearest the respective study area (Table 1). The date of peak nest starts was then related to average minimum temperatures for several time periods by means of a simple linear regression.

The form of the equation was:

$$N = B_0 + B_1T + B_2K + B_3R + B_4D$$

where: N = the number of days after 1 April when peak nest initiation occurred.

T = average daily minimum temperature for designated period,
K = dummy variable for Kindersley study area,
R = dummy variable for Roseneath study area, and
D = dummy variable for Delta study area.

The dummy variables were used to detect differences in the mean time of nest initiation at the various study areas that were not due to differences in temperature, but which might result from different techniques used by the different researchers, from differences in other climatic or environmental variables, or from regional variation in the Mallard mating system (Batt 1976).

Results and discussion

In equations 1–3 (Table 2) a 1 degree decrease in average mimimum daily temperature is associated with a delay of 1·1 to 1·3 days in the time of peak nest initiation. This relationship between temperature and time of peak nest initiation holds for each of the 4 study areas.

Of the many dimensions of weather, temperature appears as the dominant factor effecting the northward movement of Mallard and Pintail (Sowls 1955) and Canada Goose (Lincoln 1950). Therefore, it is not surprising that early temperatures on the breeding grounds could influence certain activities of early arrivals. The data suggest that average minimum daily temperature in April may be the best single dimension of temperature to explain the timing of nesting. It accounted for 60% of the variation in the times of nest initiation in the prairie and parkland area. This is not to say that a more sophisticated analysis involving more weather variables would not be an improvement.

Table 1. Location of study areas and weather stations by north latitude and longitude, by province and by gross habitat type.

Name	Study area		Weather station	
Parkland habitat				
Manitoba				
Delta	50°11′	98°19′		
Neepawa			50°13′	99°29′
Roseneath	50°08′	99°51′		
Rivers			50°02′	100°14′
Saskatchewan				
Redvers	49°34′	107°41′		
Estevan			49°08′	102°59′
Grassland habitat				
Saskatchewan				
Kindersley	51°19′	109°25′	51°27′	109°10′

Table 2. Estimates of the correlation between nest initiation and temperature.

Equation I (Temperature variable defined as average minimum daily temperature (°F) from April 11–30).

N = 66·4—1·18* temperature—9·8* Kindersley

(t = 3·94) (t = 2·99)

$R^2 = 0{\cdot}511$

Equation II (Variable defined as average minimum daily temperature (°F) from April 16–30).

N = 64·9—1·09* temperature—10·6* Kindersley

(t = 4·36) (t = 3·39)

$R^2 = 0{\cdot}569$

Equation III (Temperature variable defined as average minimum daily temperature (°F) from April 21–25).

N = 72·9—1·33* temperature—12·1 Kindersley

(t = 4·16) (t = 3·68)

$R^2 = 0{\cdot}543$

* Significant at the 99% level.

Keith (1961) had justification for doubting the high correlation he obtained between heat sums and 50% nest initiation times because he based his analysis on aggregate data for 8 species, each having a different nesting chronology (Weller 1964).

Our analysis suggests that the timing of nest initiation did not differ on the average among Delta, Redvers, and Roseneath. However, even after allowing for differences in temperature; peak nest initiation was 11 days earlier at Kindersley. Kindersley, like Gem, Alberta, 170 km WSW (Keith 1961) is occupied by Mallards and Pintails approximately 7 days in advance of the eastern prairie areas (Sowls 1955). In these species arrivals from the Pacific and western Central flyways are most likely first in extreme western Saskatchewan and southern Alberta (Lensink 1964; Bellrose 1976) with subsequent recruitment from the eastern prairies. Thus, the major difference between Kindersley and the other three areas is the early arrival of Mallard from the southwest, with later stocking from the southeast (Gollop 1965). A difference of as much as 2 days may have resulted from the different methods used to age broods and back date nests in the different study areas.

Since the analysis was based on studies conducted between 1949 and 1963, there remains the question of whether significant changes have since taken place in the nesting chronology of the Mallard due to the increased impact of agriculture (Milonski 1958: Kiel *et al.* 1972). Also, certain predator populations have greatly increased (Johnson & Sargeant 1977). An additional series of variables that may influence nest initiation are the availability of food for the maintenance and egg production of early nesters (see Perrins 1970) and microclimatic parameters such as solar radiation, wind and humidity (Porter & Gates 1969).

The existence of a stable relationship between mean minimum April temperature and nest initiation timing means that temperature can be used as an index to the lateness or earliness of nesting and, possibly, as a proxy variable in simulation or other models aimed at predicting production. Further analysis based on a more complete description of nesting effort (i.e., daily nesting effort data) would be necessary to confirm the nature of the relationship between nesting effort and temperature. The important question remaining would then be whether or not earliness or lateness of nesting affects production.

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Summary

An inverse relationship (r = −0·78) between the time of peak nest initiation of Mallard *Anas platyrhynchos* and mean minimum daily temperature was apparent for the years 1949 to 1963 at four locations within the prairie and parkland region of Canada. The quantification of this relationship can provide an index to the timing of nest initiation and could perhaps be used as a component of simulation or other models of waterfowl production.

References

Anderson, D. R. 1975. Optimal exploitation strategies for animal population in a Markovian environment: a theory and an example. *Ecology* 56: 1281–95.

Batt, B. D. J. 1976. Reproductive parameters of Mallard in relation to age, captivity and geographic origin. Ph.D. Thesis, Mich. State Univ.

Bellrose, F. C. 1976. *Ducks, geese and swans of North America.* Harrisburg, Pa. Stackpole Co.

Brown, G. M. Jr., Hammack, J. and Tillman, M. F. 1976. Mallard population dynamics and management. *J. Wildl. Mgmt.* 40: 542–55.

Dane, C. W. 1966. Some aspects of breeding biology of the Blue-winged teal. *Auk* 83: 389–402.

Dane, C. W. & Pearson, G. L. 1971. Effect of spring storm on waterfowl mortality and breeding activity. Pp. 258–267 in A. B. Haugen (ed.), Snow and Ice in relation to Wildlife and Recreation Symposium. Ames: Iowa State Univ.

Dzubin, A. & Gollop, J. B. 1972. Aspects of Mallard breeding ecology in Canadian parkland and grassland. Pp. 113–152 in Population Ecology of Migratory Birds: A symposium. *US Dept. Interior Wildl. Res. Rept.* 2.

Gollop, J. B. 1965. Dispersal and annual survival of the Mallard. Ph.D. Thesis, Univ. of Sask.

Johnson, D. A. & Sargeant, A. B. 1977. The effect of Red fox predation on the sex ratio of prairie Mallard. *US Dept. Interior Wildl. Res. Report 6.*

Kiel, W. H., Hawkins, A. S. & Perret, N. G. 1972. Waterfowl habitat trends in the aspen parkland of Manitoba. *Can. Wildl. Ser. Rept. Series* No. 18.

Keith, L. B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. *Wildl. Mono.* No. 6.

Lensink, C. J. 1964. Distribution of recoveries from banding of ducklings. US Dept. Interior, Fish and Wildl. *Special Sci. Rept. Wildl.* No. 89.

Lincoln, F. C. 1950. Migration of birds. *US Dept. Interior Fish and Wildl. Serv. Circular* 16.

Milonski, M. 1958. The significance of farmland for waterfowl nesting and techniques for reducing losses due to agricultural practices. *Trans. N. Am. Wildl. Conf.* 23: 215–28.

Milonski, M. 1958. The significance of farmland for waterfowl nesting and techniques for reducing losses due to agricultural practices. *Trans. N. Am. Wildl. Conf.* 23: 215–28.

Naylor, A. E. & Hunt, E. G. 1954. A nesting study and population survey of Canada Geese on the Susin River, Lassen County, California. *Cal. Fish and Game* 40: 5–16.

Perrins, C. M. 1970. The timing of birds' breeding season. *Ibis* 112: 242–55.

Porter, D. M. & Gates, W. P. 1969. Thermodynamic equilibria of animals with environment. *Eco. Mono.* 39: 228–44.

Smith, A. G. 1971. Ecological factors affecting waterfowl production in the Alberta parklands. *US Dept. Interior Pub. 98.*

Sowls, L. K. 1955. Prairie ducks: A study of their behaviour, ecology and management. Harrisburg, Pa: Stackpole, Co.

Stoudt, J. H. 1971. Ecological factors affecting waterfowl production in the Saskatchewan parklands. *US Dept. Interior Resource Pub.* 99.

Stoudt, J. H. 1952–1963. Annual progress reports of the Redvers waterfowl study area, Saskatchewan. Denver, Col: US Fish and Wildl. Serv.

Walters, C. J., Hilborn, R., Oguss, E., Peterman, R. M. & Stander, J. M. 1974. Development of a simulation model of Mallard duck populations. *Can. Wildl. Serv. Occasional Paper*, 20.

Weller, M. W. 1964. The reproductive cycle. Pp. 35–79. in J. Delacour *The waterfowl of the world*, Vol. 4. London: Country Life Ltd.

Yocom, C. F. 1950. Weather and its effect on hatching of waterfowl in eastern Washington. *Trans. N. Am. Wildl. Conf.* 15: 309–19.

Yocom, C. F. & Hanson, H. A. 1960. Population studies of waterfowl in eastern Washington. *J. Wildl. Mgmt.* 24: 237–50.

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