112701 SHAUGHNESSEY NO.	22 REVIEW NO.

EEB BRANCH REVIEW

DATE: IN 5-10-83 OUT 8-15-83

FILE OR REG. NO. ______

PETITION OR EXP. PERMIT NO. ______

DATE OF SUBMISSION 4-29-83

DATE RECEIVED BY HED 5-9-83

RD REQUESTED COMPLETED DATE 8-29-83

EEB ESTIMATED COMPLETION DATE 8-22-83

RD ACTION CODE/TYPE OF REVIEW 171/Old Chemical

TYPE PRODUCT(S): I, D, H, F, N, R, S Rodenticide

DATA ACCESSION NO(S). 250077

PRODUCT MANAGER NO. W. Miller (16)

PRODUCT NAME(S) Volid Rodenticide

COMPANY NAME ICI Americas, Inc.

SUBMISSION PURPOSE Submission of field data for secondary hazards of Volid to screech owls when Volid is used in orchards.

SHAUGHNESSEY NO.	CHEMICAL, & FORMULATION	% A.I.
112701	Brodifacoum	0.001

Brodifacoum (EPA Registration #10182-LI)

100 Pesticide Label Information

100.1 Pesticide Use

For *Microtus* control in fruit and nut orchards during dormant season only in the states of Virginia, West Virginia, Maryland and Pennsylvania.

100.2 Formulation Information

3-[3-(4'-bromo-[1,1'-biphenyl]4-yl)-1,2,3,4-tetrahydro-1-naphthalenyl]-4-hydroxy-2H-1-benzopyran-2-one..........................	0.001%
Inert Ingredients...........................	99.999%
	100.000%

100.3 Application Methods, Directions, Rates

"Hand (Spot) Baiting

For control of voles, apply up to 20 lb/A per season. Based on 40 trees/A, apply 2 oz total VOLID per tree for 5 lb/A. Up to four baiting spots per infested tree can be made. Cover all bait points with tire section, shingle, board, or other cover. Efficacy will be improved if such covers are placed in the field at least one month prior to bait application to ensure vole utilization.

Application need only be made to trees showing signs of infestation by placing bait underneath the tree burrows underneath bait covers. Application to border areas to help prevent invasion may also be made. Two or more placements at 1 to 2 active sites per infested tree are recommended."

"Broadcast Baiting

Hand or machine broadcast bait evenly and penetrate vegetative cover. Do not broadcast over bare ground. Apply at 10 lb/A or higher. If vole activity remains high at 2 weeks after treatment, make a second application. Do not exceed 20 lb/A per season. Be sure to pick up any pellet spills promptly, as from loading hopper, etc. Equipment allowing low broadcast rates, such as tractor mounted Lely spreader with a side deflector and small seeder ringer, are effective in applying VOLID."

General

"Apply VOLID for control of *Microtus* species such as pine voles and meadow voles during the dormant season only. Do not make applications until all fruits are harvested and harvestable drops have been removed. Removal of culls from orchard before treatment will help eliminate an alternate food supply. For best results, apply only when day time temperatures exceed 40°F.

Apply bait in active areas near trees or in active runways or burrows. In baiting, do not disturb existing vole burrows. It is recommended that all hand bait applications be individually covered with boards, shingles or other covers. Do not apply if rain is expected within 3 days, or within 7 days after picking up dropped fruit since vole burrows will have been disturbed."

100.4 Target Organisms

Microtus spp.

100.5 Precautionary Labeling

ENVIRONMENTAL HAZARD:

"This product may be toxic to fish and wildlife. Keep out of lakes, ponds, or streams. Do no contaminate water by cleaning of equipment or disposal of wastes. Baits must be placed in areas not accessible to children, pets, wildlife or domestic animals.

Do not graze animals in treated orchards. Do not use hay cut from treated areas for feed or bedding."

101 Physical and Chemical Properties

See previous reviews.

102 Behavior in the Environment

See previous reviews

103 Toxicological Properties

103.1 References from Toxicology Branch

See previous reviews and meeting reports.

103.2 Minimum Requirements

See previous reviews and meeting reports.

103.3 Additional Data

(The following data was submitted for review in this report. The complete text can be found in Accession #250077. DER's are attached to this review.)

1. The actual report is titled "The Safety to Non-target Animals of VOLID Treatments Against Orchard Voles."

   This is the registrant's summation of the 14 references cited with this submission. The registrant's conclusions were that some incidental raptor mortality could occur with the use of brodifacoum in orchards, but there would not be significant population reductions.

   EEB has reviewed the submitted references that related to this report. EEB does not agree that they support the registrant's contention that mortality is not significant in the use of brodifacoum.

2. The safety of VOLID to nontarget birds and mammals. (Previously submitted to the Agency as the summary of Section I in Request for Renewal of Experimental Use Permit No. 10182-EUP-21, July 22, 1981).

   This citation lacks the Accession Number therefore we cannot retrieve the data.

3. VanCamp, L.F. and Henny, C.J. The Screech Owl: Its life history and population ecology in northern Ohio. North American Fauna No. 71, US Department of the Interior, Fish and Wildlife Service. [1975].

   This study was the basis for the computer model. However, as the registrant concluded and from the review of the literature, screech owl numbers may be limited by the availability of nest sites. The Ohio study used wood duck nest boxes for their sampling. Therefore, the analysis of the population is based on an artificial factor. The population parameters are given without a range or confidence value; therefore their validity is not ascertainable beyond the point they indicate.

4. Bell, J., Williams, J. M. and Godfrey, M. E. R. Broadifacoum in rabbit control. (Paper to be presented at Vertebrate Pest Conference, New South Wales, July, 1983).

   This study lacks sufficient detail in regards to the submitted data to validate the reported results. Thus, the results can only be used as an indication of what might be the LD_{50} for the various species.

5. Morris, K. D. VOLID®: Acceptability of 10 ppm VOLID pellets [redacted] vs. 50 ppm VOLID pellets [redacted] using ring-necked pheasants (North Carolina). ICI Americas, Inc. Report No. TMUD3625/B] May, 1981].

   This study was inconclusive as more than one variable exists. [redacted] be shown to be a repellent based on this study.

6. Morris, K. D. VOLID®: 8-day choice test with VOLID vs. pelleted duck chow using rock doves (pigeons) (Ohio). ICI Americas, Inc. Report No. TMUD3897/B [April, 1983].

   The physical parameters and analytical chemistry of the two pellets were not given. While the pigeons may have preferred the duck chow over the [redacted] there is not a valid rationale that the [redacted] the repellency factor.

7. Kaukeinen, D. E. VOLAK: Potential hazard of the 50 ppm [redacted] broadcast at three rates as indicated by penned ring-necked pheasants (Virginia). ICI Americas, Inc. Report No. TMUD3451/B [February, 1981].

   The results suggest that further study with the VOLAK pellet is necessary before the pellet is unpalatable to pheasants, thus reducing the potential mortality.

8. Kaukeinen, D. E. VOLAK®: Potential hazard of the 10 ppm [redacted] broadcast at 3 rates as indicated by penned ring-necked pheasants (Virginia). ICI Americas, Inc. Report No. TMUD3512/B [February, 1981].

   The researcher reported that the results suggest that a 10-20 lb/A application of the 10 ppm VOLAK formulation GFU081 appears to result in lowered palatability and mortality to pheasants in this test design.

INFORMATION REVEALING INERT INGREDIENTS HAS BEEN DELETED.

The researcher compared the results from this study to another one which he regarded as inconclusive due to poor design. Thus, his conclusions and comparisons are not valid.

In addition, the "diet feed" contained therapeutic and maintenance levels of vitamin K. Since these two studies were conducted with different levels of toxicant (10 ppm and 50 ppm) and the levels of vitamin K in the maintenance diet was the same, we would expect to see lower mortality in the study with less toxicant. This study was conducted with 10 ppm.

9. Merson, M. H. Rodenticide application and vole poplulation estimation in 1981 secondary poisoning study. (Private communication). [February 8, 1982].

This is a memorandum between Mark Merson and Dale Kaukeinen. The techniques used were, for the most part, insufficiently delineated. This appears to be a preliminary report. The extent to which conclusions could be reached from this study was that some voles and other non-targets were present in the study area. Some of these non-target species were affected by the rodenticide application. (No DER could be prepared for this report.)

10. Merson, M.H. and Byers, R.E. Evaluation of brodifacoum residues in voles and nontarget animals from the 1981 secondary poisoning study. Winchester Fruit Laboratory, Virginia Polytechnic Institute and State University. [February 18, 1983].

Of nine pine voles taken pretreatment, one had a BFC residue (0.24 ppm). The posttreatment pine vole residue ranged from <0.10 to 1.86 ppm.

One of three meadow voles trapped pretreatment contained 0.15 ppm. Residue levels posttreatment for meadow voles ranged from 0.30 to 2.08 ppm.

Four of seven songbirds found during posttreatment contained detectable residues (<0.10 to 0.55 ppm).

Brodifacoum (BFC) residues in white-footed mice ranged from 3.58 to 7.00 ppm.

EEB feels that the level of detection may not be adequate. Further, the residue analysis would indicate that false positives and conversely, false negatives, are possible with the current analytical technique. In regards to the locating of dead animals, the success of finding them is proportional to the amount of time spent searching for them, a systematic means of search and the time of day. None of these factors were given in the report. The duration for which the searches should be conducted should have been in relationship to the duration or persistence of toxicity of the compound.

11. Ussary, J. P. Brodifacoum residues in screech owls and other wildlife from VOLID®-treated apple orchards. ICI Americas, Inc. Report No. TMU0910/B [February 21, 1983].

EEB believes that the residue analysis techniques may be insufficient in regards to the tissues analyzed versus the spiked tissues used as a baseline standard. The analytical technique appears to produce false positives.

12. Hegdal, P. L., Colvin, B. A., Blaskiewicz, R. W. and Schoenberg, T. A. Secondary hazards to screech owls associated with the use of VOLID (brodifacoum bait) for controlling voles in orchards. Fish and Wildlife Service, Denver. [April 20, 1983].

The researchers were attempting to determine if VOLID posed a significant hazard to local populations of raptor. This study was conducted under field use conditions in dormant fruit orchards. Out of 38 birds, only 5 were potentially exposed to BFC secondary poisoning without the influence and/or contributing factors of other toxicants (Rozol and zinc phosphide). Of these five birds, one was still alive at the end of the study, two were found dead, one of which was attributed to the use of brodifacoum, one unknown causes, and two were collected, both of which contained BFC residues in the livers. There is a strong indication, based on other feeding studies, that if these two birds had been monitored longer they too would have died. Thus, based on a very small sample size, it would appear that 75% of the local adult mortality (possibly 100%) was caused by the use of BFC for vole control.

13. Morris, K. D. Analysis of screech owl mortality as revealed by banded studies. ICI Americas, Inc. [April, 1983].

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While the author states that bird band recovery data are highly biased, he presents extrapolations from these highly biased data. Thus, the results have little meaning.

13. Morris, K. D. Analysis of screech owl mortality as revealed by banded studies. ICI Americas, Inc. [April 1983].

    While the author states that bird band recovery data are highly biased, he presents extrapolations from these highly biased data. Thus, the results have little meaning.

14. Morris, K. D. Literature review of the population biology of screech owls and other birds. ICI Americas, Inc. [April, 1983].

    This is a secondary source document. Some of the information may be useful if all the citations were available for review.

15. North, P. M. A computer modelling study of the population dynamics of the screech owl (Otus asio). Mathematical Institute, University of Kent, Canterbury. [April 26, 1983].

    Dr. North developed a computer model for screech owl populations. He then applied the model to the data collected in Hegdal, et al. (1983).

    The problems with the model are: (1) the population parameters taken from Van Camp and Henny are point data without confidence intervals or ranges; (2) the data in Van Camp and Henny are, in some cases, from disjunct sets and are not necessarily comparable; (3) the data collected by Hegdal, et al. was not sufficient to be used in the model.

104 Hazard Assessment

104.1 Likelihood of Adverse Effects

Brodifacoum (BFC) is very highly toxic to avian, mammalian, fish and invertebrate species under primary exposure. From the secondary toxicity studies that have been submitted to the Agency, it was determined that BFC has all the indications of being extremely toxic secondarily. In data (EPA Acc. # 245704) Bratt and Hundson indicate that the biological half-life in tissue of BFC is estimated to be 150-200 days. They explained that the adsorption of brodifacoum may be a saturable process with fecal excretion increasing rapidly thereafter. Bell, et. al. (EPA Acc. #250077) state in their report "Daily treatment with 2 mg/kg^{-1} of vitamin K^{1} for at least 5 days after intoxication prevented any dog deaths occurring, even when treatment was delayed until obvious signs of anticoagulent poisons appeared. However, since these studies it has been found that several such treatments can reoccur after a successful initial treatment." Between these two studies, it would appear that once a mammal is exposed to BFC it could take several years before the animal system breaks it down to non-toxic compounds. From Bell, et al. the use of vitamin K^{1} would appear to mask the actual effects of brodifacoum in acute oral and dietary studies. This would seem to support the premise that EEB has stated in previous reviews, memorandums, and meetings - The use of dietary feed containing therapeutic levels of vitamin K compounds interfere with the results of primary and secondary hazard testing. Thus, the values reported, which are general in the very highly toxic category, could err on the side of safety.

Mendenhall and Pank (1980), Marsh and Howard (1978) and Savarie and LaVoie (1979) (EPA Acc. #245708) produced preliminary reports that indicated that brodifacoum formulations were secondarily toxic to raptors under laboratory conditions. Each of these studies had some sort of anomaly that precluded it from a totally acceptable study. Therefore, the reviewers classified these as supplemental information but with enough scientific integrity to be used as indication of potential raptor secondary hazard through the use of BFC. Other data that have been submitted in regards to mammals and secondary toxicity have been evaluated as not supporting registration. Again, as with the avian studies, these mammalian studies give indications as to the potential secondary hazard to predator.

The registrant has applied for and received EUP's to study efficacy of BFC against field rodents. During the review of the EUP results, incidental observations indicated that passerine and upland game birds, as well as rabbits, were found dead. In addition, there have been unconfirmed reports that dogs near treatments sites have had symptoms of anticoagulent poisoning. There have been unconfirmed reports that livestock in foreign countries have been killed in areas where brodifacoum has been used. There was an article in Pest Control (January, 1981, Vol. 49:54) that strongly implied that insectivovous birds died from eating ants and roaches that were feeding on Talon (a brodifacoum formulation). Most of these reports are circumstantial, as the corpses were not analyzed for residue, or the reports were based on hearsay.

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EEB's rationale for bringing up these reports is that they could have (if it had been possible to confirm them) supported our hazard assessment that BFC poses a significant impact to non-target populations.

The present submission (EPA Acc. #250077) was to be the definitive field research for brodifacoum in orchards (a field use). If the field use of brodifacoum in orchards did not pose a significant impact to raptors (secondarily) and other non-targets (primarily and secondarily), then EEB could complete a hazard assessment favorable to the registration of the product.

The Hegdall et al. (1983) study indicates that 80% of the screech owls associated with brodifacoum-treated orchards died. One screech owl died of confirmed brodifacoum poisoning; two screech owls were collected with residue levels similar to those that died from BFC poisoning; one died of undermined causes; and one was still alive at the end of the study. Due to the time of the year of the study and the behavior patterns of screech owls, these birds should represent the breeding population for the following breeding season.

Thus, it would appear that the use of BFC baits in dormant orchards is going to affect 60-80% of the adult breeding population of screech owls. EEB's conclusion is that the use of brodifacoum in orchards poses a significant hazard to screech owl (i.e., raptors) populations.

ICI Americas, Inc. has attempted to vindicate this significant population reduction through use of a computer modeling program and explanation of population dynamics. First: the modeling program was based on population parameters that even its developer felt were statistically unacceptable. Further, the program was not applied to the data that would support the original hypothesis. Finally, the program integrates adult and juvenile mortality when the population in question should be considered adult. Second: the main population dynamics that the registrant depicts, is replacement through immigration from sub-optimal habitat. However, if the habitat is sub-optimal, then one would expect sub-optimal fecundity. The sub-optimal fecundity would result in fewer birds immigrating into the optimal habitat. To which, 60-80% of the migrants could die due to brodifacoum treatments, and up to an additional 39% of the remaining adult population (Van Camp and Henny, 1975) would die from natural mortality. Another point to consider is that the sub-optimal inhabiting birds are mostly emigrants from optimal habits. If the optimal habitats cannot support the optimal population levels due to increased mortality, then the sub-optimal populations, over time, will decrease in numbers, which further decreases the overall fecundity rate.

104.2 Endangered Species Consideration

Due to the significant impact to non-targets, EEB does not feel that a formal consultation with OES is warranted for the orchard use pattern of BFC. However, if the Registration Division determines that this product and use pattern are registerable, EEB believes that a formal consultation should be initiated and completed prior to registration.

104.3 Hazard Assessment Conclusions

Brodifacoum, when used in orchards, causes significant (60 to 80%) screech owl (e.g., raptor) population reduction. In addition, nontarget mortality (avian and mammalian) was reported but could not be quantified. Previous EUP and data submissions on field uses indicate that BFC is very highly toxic (primarily and secondarily) and very persistent in the environment and animal tissues. EEB feels that the data presented in EPA Acc. #250077 further confirms previous suspicions that the field use of brodifacoum will cause significant population reduction of nontarget species.

107 Conclusions

EEB has completed a full risk assessment (3(c)(5) finding) of the proposed registration of brodifacoum (VOLID-EPA Registration No. 10182-LI) for use in orchards. Based upon the available data and use information, EEB concludes that the proposed orchard use provides for potentially serious hazards to nontarget organisms.

Russel T. Farringer, III — Date: 8/22/83
Wildlife Biologist
Ecological Effects Branch/HED

Raymond Matheny — Date: 8/22/83
Head, Review Section I
Ecological Effects Branch/HED

Clayton Bushong — Date: 8/22/83
Branch Chief
Ecological Effects Branch/HED

Note to PM: Representatives from ICI Americas, Inc. will undoubtedly request a meeting in regards to this review. EEB will need the following information in hand at least six weeks prior to such a meeting

1. All previously submitted Fish and Wildlife Packages (Data Submissions).

2. Copies of all minutes of previous meetings and any correspondence in regards to all BFC registration actions.

3. Fully readible and complete copies of all references in EPA Acc. #250077 for the following studies:

   Reference 11-T, Hegdall, et al., 1983
   Reference 14-I, North, 1983.

   In addition, final (<u>not</u> preliminary) reports for all references in Acc. #250077.

4. The following studies are to be deferred to the respective Branches for review. The copies of their reports for these studies should be in EEB's possession at least four weeks before the meeting.

   (Note: Studies marked with an (*) were previously deferred to the respective Branches but were never transmitted from RD to them.)

   <u>Toxicology Branch/HED</u>

   Accession #245704

   Study #'s - 10*, 18, 19*, 20*, 21*, 22, 23*, 24*, 25, 26

   Accession #25077

   Study # - 3I

   <u>Residue Chemistry Branch/HED</u>

   Accession #245704

   Study #'s - 10*, 11*, 12, 13*, 25

   Accession #25077

   Study # - 9I, 10I

   In addition, the complete Gram 2/1, HPLC technique should be supplied to them. The modifications of this technique alluded to in ABC, Inc. report (10I) to ICI should be delineated completely. All recovery data that are available for the Gram 2/1 technique,

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that ICI and/or its contractors' subsidiaries have, should be made available to the Residue Chemistry Branch.

5. The registrant should submit in writing specific questions and/or points that they wish to discuss at least six weeks prior to the meeting.

6. The registrant should submit the complete text of the computer program they used for their population model. EEB requires this program in order to utilize the data as we see it in an identical computer print-out for comparison to Dr. North's printouts.

DATA EVALUATION RECORD

1. Chemical: Brodifacoum

2. Formulation: None. Chemical support document.

3. Citation: Van Camp, Laurel F., & Charles J. Henny (1975). The Screech Owl: Its Life History and Population Ecology in Northern Ohio. USDI, FWS, North American Fauna, Number 71 published by Fish and Wildlife Service. 63 pp. Acc. #250077.

4. Review by: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. Date Reviewed: 7/26/83

6. Test Type: Life history and population information (30 yrs).
   Test species: Screech Owl.

7. Reported Results: - NA -

8. Reviewer's conclusions: (See end of Review).

Study Purpose: Research into screech owl (Otus asio) breeding biology and population dynamics.

Study Duration: 1944-1973

Study area: Along rivers, creeks, and marshes in Ottawa, Sandusky, Wood and Lucas County, Ohio.

Study Methods: Establish wood duck nesting boxes and monitor the screech owls utilizing the boxes.

The following material was considered salient points from this study. The entire report is in this reviewer's file.

Page 3. The Study Population.

"The screech owl population reported herein is one that nested in wood duck boxes in northern Ohio between 1944 and 1973. The fact that the birds were using artificial nesting structures may cause a bias in a portion of the findings, particularly in terms of population trends (indices) and annual recruitment rates. For example, trends in population numbers should not be based on the percentage of the nest boxes occupied each year because the nest boxes were always placed in suitable habitat. A population reduction from the loss of habitat would be undetected by such an approach. Our population index most likely represents the annual population nesting in suitable habitat. We believe, however, that most of the other findings presented in this paper are representative of the wild screech owl population in the study area, and, as such, were not biased by the type of nest site used."

Page 6-8 Accumulation of Data .

"A measure of the annual and seasonal effort to conduct this study of importance. Unfortunately, the person-days spent in the field are not recorded. The number of nest boxes checked during the nesting season provides an index of annual effort during the 30-year study. This measure is admittedly crude because the number of visits to each nest box was not recorded. For example, some of the boxes could not be visited more than once during several of the years (for additional details see results). Forty-five boxes were checked in 1944, the first year of the study. The average number of nest boxes checked for each 5-year period during the study was as follows: 479, 727+, 985+, 730, 650, 678. The exact number of nest boxes checked from 1952 to 1955 is unknown; however, a high percentage of the boxes were checked only once at the time young were about to fledge. From 1956 to 1973, the annual effort was consistent. More than 4,249 boxes were checked during the 30-year period.

Breeding Season

Pairs appeared in the nest boxes by the first week of February. During the initial years of the study, some nest desertions resulted from visiting the boxes in February and March. Therefore, in later years the nest boxes were not checked before mid-April. Most screech owls were incubating by mid-April, and unless the incubating birds were handled, the nests were not deserted. Nest boxes were checked at this time and the males banded if they were in the nest box. Females were not handled until the young hatched. The nest boxes were generally checked three times between mid-April and early June. The females were banded during the first check in which young were in the nests. The young were not banded until the color phase could be determined.

Postfledging Period

Nest boxes were little used after the young fledged, but use began to increase in October when the deciduous trees lost their leaves. We visited nest boxes only rarely in late summer or early fall.

Winter Period

November, December, and January was a period of much nest box use by individual birds. The wood duck boxes were checked periodically during these months and a large number of screech owls was banded. Beginning in the early 1960's all boxes were visited during the annual maintenance check in January; not all boxes were visited during the winter in the earlier years.

In addition to roosting, the screech owls used the boxes for feeding stations during winter. The trait of carrying prey to a cavity before feeding may have evolved: (1) to lower screech owl vulnerability to predation by larger owls, (2) to prevent other animals from eating the prey not consumed immediately by the owls, (3) as a food storage technique to carry the owls over periods of inclement weather or periods of low food availability, or (4) from the habit of the male feeding the female (Burton 1973). This food carrying trait accounts for the large number of prey items recorded in the nest boxes. As mentioned above, the owls did not use the nest boxes in late summer or early fall when the leaves of deciduous trees are present. We believe the dense foliage protected the screech owl from predation by larger owls during this period. Thus, the need for using a cavity as a feeding station was minimized in the late summer and early fall."

Page 9-10 Food Habits

"The screech owl is one of the most nocturnal of North American owls. Allen (1924) made a series of observations on the feeding of a brood of young and concluded that the earliest time at which feeding began was 2025, and the latest was 2112; the earliest time at which feeding ceased was 0250, and the latest was 0415. He further reported that both parent birds were engaged in caring for the young. These nighttime hunts yielded a variety of food items including many passerine birds that were apparently captured on their roosting sites.

The food habits of most birds of prey were first studied in detail during the latter part of the 19th and early 20th centuries. Notable publications of this era were by Fisher (1893) and Errington (1932). In summary, they reported that the screech owl diet consisted of mice, shrews, rats, other mammals, small birds, lizards, amphibians, fish, crayfish, insects, spiders, and other invertebrates. Bent (1938) indicated that although birds do not form as large a portion of the food as mammals, the list of species is a long one. More recently, James and Martin (1950) and Stewart (1969) have added several species of birds to the list.

McDowell and Luttringer (1948) estimated that the diet (percentage occurrence) of the screech owl consisted of 22.75% mice, 18% other mammals, 18% songbirds, with the remaining 41.25% reptiles, amphibians, fish, and insects, and other invertebrates. An analysis of 419 pellets collected in western Missouri from 1957 to 1967 showed a preponderance of small rodents in screech owl diets (Korschgen and Stuart 1972). Mice and rats together made up 87% of all foods. Songbirds amounted to 8.4% in occurrence and only 4.1% of the volume. Among birds in portions of the southwestern United States and western Mexico, Ross (1969) lists the common screech owl as being both carnivorous and insectivorous, the whiskered screech owl as being primarily insectivorous but on occasion supplementing its diet through carnivorous predation, and the flammulated screech owl, as being entirely insectivorous. Errington (1932) indicated that as a rule screech owls ate what was most convenient to catch and of a size easy to handle. He further noted that their preferred prey seemed to be mice if such were available, but in the event of a mouse shortage they readily turned to birds. These studies suggest that the screech owl is an opportunistic predator whose diet includes nearly every class of animal life."

Page 16: <u>Seasonal Variation</u>

"Table 4: The relative importance of birds to mammals in the seasonal diet of the screech owl (data obtained from nest boxes).

Time Collected	No. Mammals	No. Birds	Percent Birds[a]
Nesting season...	145	309	68
Fall and winter..	73	32	30

[a]The aggregate of birds plus mammals."

Page 18:

"Table 6. The relative importance of birds to mammals in the seasonal diet of the screech owl (data obtained from 479 stomach content cards at Patuxent Wildlife Research Center).

Month Collected	Stomachs Checked	No. Mammals	No. Birds	Percent Birds[a]
January	56	33	15	31
February.........	34	15	5	25
March............	38	21	6	25
April............	28	8	11	58
May..............	46	3	4	57
June-July........	40	3	6	67
August-September.	23	5	4	44
October..........	40	21	8	28
November.........	98	52	17	25
December.........	76	45	14	24

[a] The aggregate of birds plus mammals. April-September the percentage of birds was 57, whereas the percentage for October-March was 26. Other vertebrates in the stomachs include 7 toads, 7 frogs, 2 lizards, and 3 fish."

Page 27: <u>Clutch Size</u>

"Table 10. Clutch sizes of screech owls in northern Ohio compared with egg sets in 12 museums (nearly all museum sets were collected before 1900).

Location	Clutch size								n	Mean
	1	2	3	4	5	6	7	8		
Northeast[a]......	0	3	17	36	28	8	0	1	93	4.27
Northern Ohio[b]..	0	1	10	37	35	8	0	0	91	4.43

Northcentral[c]...	0	0	2	7	6	3	0	0	18	4.56
Midwest[d]........	0	1	6	5	3	0	0	0	15	3.67
Arkansas-Oklahoma-Texas.........	0	0	7	9	0	0	0	0	16	3.56
Georgia-South Carolina-Tenn.	0	2	5	3	0	0	0	0	10	3.10
Florida.........	1	13	32	7	4	0	0	0	57	3.00

[a] Massachusetts, Rhode Island, New York, Pennsylvania, New Jersey, Maryland, and Washington, D.C.
[b] Does not include one clutch of 10 eggs.
[c] Ohio, Indiana, Illinois, and Wisconsin.
[d] Missouri, Iowa, Kansas, and Nebraska."

Page 28: Nesting Success and Fledging Rate

Table II. Success of screech owl nests in northern Ohio, 1944-73.

Year	No. active nests	No. nests successful[a]	Percent of nests successful[b]	No. young fledged	Young fledged per successful nest
1944	4	4	100.0	17	4.25
1945[c]	5	4	80.0	16	4.00
1946[c]	9	6	66.7	22	3.67
1947[c]	19	14	73.7	56	4.00
1948[c]	20	11	55.0	37	3.36
1949[c]	19	15	78.9	61	4.07
1950	26	24	92.3	87	3.63
1951	11	10	90.9	39	3.90
1952	25	23	92.0	85	3.70
1953	34	31	91.2	116	3.74
1954	49	44	89.8	197	4.48
1955	42	42	100.0	161	3.83
1956	22	20	90.9	81	4.05
1957	16	14	87.5	54	3.86
1958	17	14	82.4	50	3.57
1959	15	12	80.0	49	4.08
1960[c]	17	11	64.7	40	3.64
1961[c]	12	9	75.0	32	3.56
1962	20	18	90.0	70	3.89
1963[c]	16	11	68.8	40	3.64
1964	9	9	100.0	34	3.78
1965	8	7	87.5	29	4.14
1966	9	9	100.0	30	3.33
1967[c]	18	16	88.9	54	3.38
1968	13	13	100.0	49	3.77
1969[c]	12	10	83.3	35	3.50

1970	13	12	92.3	45	3.75
1971[c]	13	11	84.6	34	3.09
1972	18	16	88.9	53	3.31
1973[d]	-	-	-	-	-
Total	511	440	86.1	1,673	3.80

a Fledged at least one year.
b This percentage is biased high because many nests were visited only once when the young attained bandable size.
c Years when 75 percent of nests were visited on two or more occasions.
d Data excluded because one egg from each clutch was collected for pesticide study.

Page 29:

"Table 12. Number of young screech owls per successful nest during five banding periods (from early to late nesters) in northern Ohio.

Banding date[a]	Successful nests	Number banded	Mean per nest
22 April - 9 May	88	367	4.17
10 May - 9 May	88	336	3.82
16 May - 9 May	88	335	3.81
20 May - 9 May	88	334	3.80
24 May - 9 May	88	301	3.42
Total	440	1,673	3.80

a The banding dates were adjusted so that an equal number of successful nests were reported in each banding period."

Page 33: <u>Sex Ratio in Population</u>

"Data obtained in our study area could not be analyzed for sex ratio information because of the potential bias associated with the sampling scheme (nearly all birds captured at nest boxes were paired)."

Page 34: <u>Mortality Rats</u>

Table 15. Estimates of mortality rates for screech owls banded as nestlings and adults in the northeastern United States and Ontario during 1915-64.

Age interval years	Adults[a] Number of recoveries	Alive at beginning	Mortality rate	Nestlings Number of recoveries	Alive at beginning	Mortality rate
0-1	55	134	0.328[b]	73	105	0.695[c]
1-2	25	79		13	32	0.690[b]
2-3	13	54		7	19	
3-4	9	41		4	12	
4-5	7	32		2	8	
5-6	8	25		2	6	
6-7	6	17		3	4	
7-8	3	11		1	1	
8-9	5	8		0	0	
9-10	1	3		0	0	
10-11	1	2		0	0	
11-12	0	1		0	0	
12-13	1	1		0	0	

a An initial date of the first 15 May after banding was used for all birds not banded as nestlings. On this date, the birds were arbitrarily classified as adults.
b Annual adult mortality rate estimate.
c First-year mortality rate estimate.

Page 37: <u>Age at Sexual Maturity</u>

Conclusions regarding the percentage of the 1-year old screech owls that attempt to nest annually must be regarded as tentative at this time. Furthermore, the percentage may fluctuate from year to year. Our two estimates (based on very small sample sizes) suggest that an average of possibly 77 to 83% of the 1-year olds attempt to nest annually, but the percentage may be lower.

Page 58-59. <u>Life Equation Approach</u>

"A mathematical model showing the relations between population parameters that yield stable populations was developed by Henny et al. (1970). Information needed for the model includes (1) mortality rate schedules (obtained from recoveries of banded birds), (2) recruitment rates, and (3) age at sexual maturity. Estimates of these parameters have been presented in this paper for the screech owl.

We know that screech owls are capable of breeding at the end of their first year of life (as 1-year olds), although the percentage in this age class that breeds is not known with certainty. However, we still believe that the exercise in constructing a life-equation model is worthwhile, because it will point out future research needs and act as a check on the internal consistency of the input data. Adult mortality rate estimates for the screech owl range from 32.8 to 39.0% (Table 15), with a pooled estimate of 33.9%. The mortality rate estimate for the first year of life was 69.5% (Table 15). The observed recruitment rate per breeding pair was estimated at between 2.55 (Table 13) and 2.63 based on the exposure-day method.

Initially, let us assume that all screech owls breed as 1-year olds, although we have some evidence that a portion of the 1 year olds do not nest. The estimated number of young that must be fledged per breeding-age pair to maintain a stable population may be estimated by the following formula (from Henny 1972):

$$\bar{m} = \frac{1 - s}{s_o \, (1 - s + s_1)}$$

where

$\bar{m}$ = the average number of female fledglings produced per breeding-age female ($2\bar{m}$ = the total number of young produced per breeding female assuming an equal sex ratio of fledglings).
s = third year and later survival rate
s_o = first year survival rate
s_1 = second year survival rate

By using the pooled estimate for adult mortality and assuming that all 1-year olds attempt to nest, it is estimated that only 2.22 young are required per breeding pair to maintain a stable population. This is slightly less than the observed recruitment (2.55 to 2.63), and, although the mortality rates may not be precise, the modeling approach suggests that not all 1-year-old screech owls need to attempt to nest annually in order to maintain a stable population. To pursue this matter a little further, let us assume for the moment that the recruitment rates and the mortality rates are correct and, through the modeling process, let us calculate the percentage of 1-year-olds (solve for p_1) that must attempt to nest annually to balance the life equation (see Equation 1 in Henny 1972:6). Given the above constraints and assuming that 2-year-olds and older attempt to nest each year, the population could remain stable if at least an average of 60% of the 1-year-olds nested annually. This estimate is in fairly close agreement with the 77 to 83% estimate based on a small sample of field data which may be biased upward."

Page 60-61 Summary

1. The life history and pupulation ecology of the screech owl was studied in northern Ohio between 1944 and 1973. The owls nested in boxes established for wood ducks. The birds were banded and periodically recaptured. Food habits, productivity information, and color phase of the parent birds and offspring were recorded.

2. The screech owl is an opportunistic feeder. The diet changes with the seasons of the year, i.e., during the nesting season migrant birds replace mammals in importance, and during the late summer insects become important.

3. There is no evidence from banding data to suggest that screech owls in the northeastern United States migrate.

4. Young screech owls begin dispersing from their natal areas in late summer or early fall, with only about one fourth of the young birds remaining within 10 km (6 mi) of the banding site. On the contrary, adult birds remain close to the area where they previously nested.

5. The hypothesis of random dispersal distance in young screech owls was rejected. There appear to be two groups in the population: (1) a group showing little dispersal, and (2) a group wandering considerable distances.

6. The directional pattern of dispersal was random.

7. Pairs of screech owls were noted in the nest boxes in early February, but egg laying did not peak until about 15 March. Hatching takes place in mid-April to early May and most of the young leave the nest the last week of May or the first week in June.

8. The mean clutch size was 4.43 with a mean of 3.80 young fledged per successful nest. An estimated 69.2% of the nesting attempts were successful.

Including unsuccessful nesting attempts, an estimated 2.55 to 2.63 young were fledged per breeding pair.

9. Annual variation in the number of young fledged per successful nest was small. The lack of variability was probably due to the predictable food source of passerine birds that migrated through the area each spring when young were in the nest. This contrasts with the highly variable productivity reported for owls dependent upon local cyclic rodent populations.

10. Raccoon predation was implicated in a number of unsuccessful nesting attempts, but the overall effect of the raccoon on the screech owl population was not fully assessed.

11. The sex ratio in the population did not differ significantly from a 50:50 ratio.

12. The first year mortality rate of the screech owl was estimated at 69.5%; adult mortality was estimated at 33.9%.

13. Male and female screech owls banded as nestlings were known to nest successfully at the end of their first year of life (as 1-year-olds). Two estimates of the average proportion of 1-year-olds nesting ranged from 77 to 83%, but the percentage may be lower.

14. No significant eggshell thinning was detected in the population in 1973, and residue levels of DDE and PCB's were low.

15. In northern Ohio, the screech owl population consists mainly of a gray- and red-phased birds, but about 2 to 3% of the birds are intermediate in color.

16. A significant change in the ratio of red- to gray-phased birds occurred in December 1951. This change coincided with the lowest temperatures during the 30-year study and the heaviest snowfall. The red-phased birds decreased from 23.3% of the population to 14.7%. Additional evidence from retrap information suggests that the grays survived much better than the reds during the stressful period. The ratio of reds in the population failed to increase to pre-1951 levels during the next 20 years.

17. No significant relationship existed between sex and color phase in our sample of 760 nesting screech owls.

18. The following hypotheses of gene action remain: (1) If the intermediate phenotype is assumed to be due to genetic modifiers, the difference between red and gray is due to one pair of alleles, the gene for red exhibiting dominance over its allele for gray; or (2) if all three colors are considered, the colors are inherited on the basis of a series of three alleles with a graded order of dominance of red->intermediate->gray.

19. No significant difference in brood size and color phase of the parents could be detected.

20. An index to annual abundance suggests that the screech owl population fluctuated in northern Ohio during the last 30 years, but with no long-term trend apparent in available habitat. The life-equation approach also suggests that, over the long term, productivity probably balanced mortality.

Reviewer's Evaluation

This study, while long in duration (30 years), was artificial in its scope. While using wood duck nest boxes as a means to survey the screech owl population, one could ascertain that this was a bias toward optimum man-made population dynamics. Further, since the boxes were placed in "optimum habitat," one would expect that the fledgling success and population dynamics associated with this sampling would be relatively stable.

The results from this study in regards to nest success, fledgling success, and survival could be used as indicators for similar studies using wood duck nest boxes.

Category - Supplemental.

Rationale - Data is presented as points without ranges, or confidence levels. The use of wood duck nest boxes introduces an artificial parameter that could have great influence on the population parameters.

Repairability - None

DATA EVALUATION RECORD

1. Chemical: Brodifacoum

2. Formulation: Technical Formulations

3. Citation: Bell, J., J.M. Williams, M.E.R. Godfrey. (Date ?) Brodifacoum in Rabbit Control. (Citation is deficient due to incomplete report) New Zealand Study, Acc. #250077.

4. Review by: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. Date Reviewed: 7/27/83

6. Test Type: Efficacy, secondary and primary hazards, field monitoring report.
   Test species: Numerous- See table in text of this report.

7. Reported Results: See text of this report.

8. Reviewer's conclusions: Insufficient material in report to arrive at a valid conclusion.

Methods/Materials

Test Procedure

The LD_{50} data was submitted without a test protocol.

The rabbit efficacy part of the report used the following techniques:

Pre-survey of the area by spotlighting at night to determine rabbit density. A 0.005 percent brodifacoum cereal bait was prepared. Two thousand to four thousand baits were placed per hectare. The area was monitored for over thirty days.

Results and Discussion (Quoted material from report)

"Rabbit numbers were reduced over 12-14 days by 95-98 percent. Most deaths occurred between the 4th and 8th day, but some occurred after 30 days. Over 75 percent of the baits were eaten after three nights feeding. Sheep, cats (Felis catus) and several bird species were accidentally killed. Liver, fat and muscle tissues from rabbits were analyzed and up to 11.7, 2.1 and 0.8 ppm recorded. These high levels pose risks for rabbit predators and the lengthy retention in the liver of sheep may cause restrictions on the toxin's use. Lower levels of poison in the baits and other approaches should overcome these problems."

"Table 1. Toxicity of brodifacoum to target* and nontarget species.

Species	LD_{50} mg/kg^{-1}	95% Confidence Limit
Mammals		
Possum* (*Trichosurus vulpecula*)	0.17	?
Rabbit* (*Oryctolagus cuniculus*)	0.2	0.15 - 0.28
Wallaby* (*Macropus rufogriseus*)	1.3	0.65 - 2.7
Dog (*Canis familiaris*)	3.5	2.13 - 6.03
Sheep (*Ovis aries*)	33.0	5 - 210
Birds		
Pukeko (*Porphyrio melanotus*)	0.95	0.43 - 2.05
California quail (*Lophortyx californica*)	3.3	2.2 - 5.2
Mallard duck (*Anas platyrhynchos*)	4.6	0.6 - 34.5
Harrier hawk (*Circus approximans*)	10.0	4.6 - 21.6
Ring necked pheasant (*Phasianus colchicus*)	10.0	5.0 - 20.0
Black backed gull (*Larus dominicans*)	Less than 0.75	
Canada goose (*Branta canadensis*)	Less than 0.75	
Black billed gull (*Larus bulleri*)	Less than 5.0	
Blackbird (Turdus merula)	More than 3.0	
Hedge sparrow (*Prunella modularis*)	More than 3.0	
House sparrow (*Passer domesticus*)	More than 6.0	
Silvereye (*Zosterops lateralis*)	More than 6.0	
Paradise duck (*Padorna variegata*)	More than 20.0"	

"Toxicity to the birds listed in Table 1 indicate that brodifacoum is probably no more hazardous than toxicants currently in use."

"The higher the dose of brodifacoum given to sheep the greater the amount excreted in the first 7-10 days. Residues in sheep liver of 1.95-2.34 mg/kg^{-1} were recorded after 113 days (Rammell, C. per comm.) indicating a long half life. This aspect is being investigated further using analytical techniques that can detect to 0.02 mg/kg^{-1}."

"Nontarget hazard studies concentrated on dogs and sheep, the former because they are extremely sensitive to 1080 and it was hoped brodifacoum would prove much safer.

The oral toxicity was tested with dogs of mixed breed, age and sex and an acute oral LD_{50} of 3.56 mg/kg^{-1} was derived (Godfrey et al. 1981b). Preliminary results indicated a chronic LD_{50} of approximately 4.0 mg/kg^{-1}. Daily treatment with 2 mg/kg^{-1} of Vitamin K^1 for at least 5 days after intoxication prevented any dog deaths occurring, even when treatment was delayed until obvious signs of anticoagulant poisons appeared. However since these studies it has been found that several such treatments may be needed because hemorrhaging can reoccur after a successful initial treatment."

Reviewer's Evaluation

Category: Invalid.

Rationale: The report was insufficient in detail to prepare validation categories. The material quoted above can only be used as indications of what LD_{50} is to the respective species.

Repairability: If the raw data and citations with their raw data were available this might allow a validation of core.

INFORMATION REVEALING INERT INGREDIENTS HAS BEEN DELETED.

DATA EVALUATION RECORD

1. Chemical: Brodifacoum

2. Formulation: Volid 10 ppm [redacted]
   Volid 50 ppm

3. Citation: Morris, K.O. and D.E. Kawkeinen (1981) Volid™: Acceptability of 10 ppm Volid Pellets [redacted] vs 50 ppm Volid pellets [redacted] using ring-necked pheasants. Acc. #250077.

4. Review by: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. Date Reviewed: 7/28/83

6. Test Type: Food preference.
   Test species: Ring-necked Pheasants

7. Reported Results: The pheasants appeared to be repelled by [redacted] formulation.

8. Reviewer's conclusions: This study was not scientifically sound. The hypothesis that [redacted] indicates that [redacted] formulation has greater repellency is not supported when the rest of the variables are not equal (the toxicant).

Materials/Methods

Study Procedure

Birds were survivors of a previous field study.
Prior to study birds were maintained on grains and water *ad lib*.
Fasted 24 hours prior to study
Study duration: 1-day
Number of test group: 2/test material
Number of birds per group: 5

Reviewer's Evaluation

Category: Invalid.

Rationale:

If a study is to determine repellency of a product with different adversive agents, all factors other than the repellent should be equal. In this study, a 50 ppm and a 10 ppm brodifacoum pellet was utilized. The 50 ppm contained [redacted] the 10 ppm [redacted] therefore the level of toxicant could be the repelling and/or acceptance factor. Previous history of the birds was not adequately covered. These birds could have been pre-conditioned to [redacted] during the previous study in which they were used. Further, even if the study had proved [redacted] in the formulation repelled pheasants, no data was submitted to prove repellency in other species.

Repairability: None

INFORMATION REVEALING INERT INGREDIENTS HAS BEEN DELETED.

DATA EVALUATION RECORD

1. Chemical: Brodifacoum

2. Formulation: Volid (3/32 inch - 10 ppm brodifacoum [redacted]

3. Citation: Volid®: 8-day Choice Test with VOLID vs Pellet Duck Chow Using Rock Doves (Pigeons). Bowling Green State University (1982). Acc. #250077.

4. Review by: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. Date Reviewed: 7/28/83

6. Test Type: Feeding choice
   Test species: Rock Dove (pigeons)

7. Reported Results: It would appear that Volid is significantly rejected by Rock doves when alternate food is available.

8. Reviewer's conclusions: The conclusions drawn by the researcher are not substantiated by the report. The report does indicate that if Rock doves are given a choice between feeding on Volid [redacted] and duck chow, they will select the duck chow. However, to conclude that Volid [redacted] are not acceptable to rock doves strains the "scientific" research that was conducted. The following questions pose the areas where the study and subsequent report lacked integrity.

   a. What size of duck chow pellet was utilized?

   b. What aromatic properties does the duck chow pellet have?

   c. Was an analysis of the duck chow pellet and an analysis of the VOLID pellet conducted in order to determine if their respective constituents were similar?

   d. Were the pellets of equal hardness?

   e. What was the source from which the birds were obtained?

   f. Were there any observations that could explain why on 5 out of 8 days water was in the Volid bowls in both pens? How was the weight of the Volid consumed out of these bowls determined on these days?

   g. During the "conditioning period" the test indicates that corn grit was used for feeding while the

INFORMATION REVEALING INERT INGREDIENTS HAS BEEN DELETED.

graphic presentation indicates duck chow and VOLID pellets. What foods were utilized in the conditioning period?

Category: Invalid

Rationale: See Above

Repairability: None.

INFORMATION REVEALING INERT INGREDIENTS HAS BEEN DELETED.

DATA EVALUATION RECORD

1. Chemical: Brodifacoum

2. Formulation: Volak 50 ppm [redacted]

3. Citation: Volak®: Potential Hazard of the 10 ppm [redacted] Broadcast at 3 Rates as Indicated by Penned Ring-necked Pheasants. ICI Americas (1981) Acc#250077.

4. Review by: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. Date Reviewed: 7/28/83

6. Test Type: Field study - cage birds
   Test species: Ring-necked pheasant

7. Reported Results: The results suggest that a 10-20 lb/A application of the 10 ppm VOLAK formulation GFU081 appears to lower palatibility and mortality to pheasants in this test design.

8. Reviewer's Conclusions: This study is biased by the use of "diet feed" containing Vitamin K. The results given above are compared by the researcher to a study with 50 ppm VOLAK which he determined was not scientifically sound.

Materials/Methods

Study Procedures

Twelve groups of 6 female pheasants were housed in adjacent pens of 512 sq. ft. near an orchard. Each pen received one of three broadcast treatments or served as a control.

Pellets: 3/16 inch GFU081 formulation [redacted] 10 ppm concentration.
Bodyweight: Year-old birds 810 g average (636-990g)
Pens: 3 per treatment; 3 treatments
Treatment level: 0, 10, 20, 100 lbs/acre

Results

Treatment Level	Dead	Percentage
0	0	0
10	1/18	6%
20	1/18	6%
100	7/18	39%

Seven out of nine of the dead birds died 4 to 10 days after treatment with the other two birds dying on day 25 and 39 post-treatment.

Reviewer's Conclusions

Category: Invalid

Rationale: While this study may indicate less hazard with the reduced toxicant level, the comparison is to a study (50 ppm) in which most of the mortality could be attributed to causes other than the toxicant. Further, the maintenance diet contained Vitamin K complex which may be antidotal to the toxicant. Without a baseline data set on this diet versus a diet without added vitamins, antibiotics and drugs to control protozans, this study will not support the intended purpose of showing reduced hazards under field conditions.

Repairability: None

INFORMATION REVEALING INERT INGREDIENTS HAS BEEN DELETED.

DATA EVALUATION RECORD

1. Chemical: Brodifacoum

2. Formulation: Volak 50 ppm [redacted] 3/16" pellets

3. Citation: Volak: Potential Hazard of the 50 ppm [redacted] Broadcast at Three Rates as Indicated by Penned Ring-necked Pheasants. Test #24VA79-045 (1979) Acc# 250077.

4. Review by: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. Date Reviewed: 7/28/83

6. Test Type: Primary hazard field study
   Test species: Ring-necked pheasant

7. Reported Results: The results suggest that still further modifications should be studied with the VOLAK pellet to possibly reduce pheasant palatibility and mortality.

8. Reviewer's Conclusions: This reviewer agrees with the results stated above.

Materials/Methods

Test Procedure

Wire pens 8 X 64 ft (512 sq. ft.) were used. Pens were surrounded by metal flashing around the bottom edge extending into the ground 6 inches and above the ground 18 inches.

Three pens of 512 sq. ft. were used for each level plus controls for a total of 12 pens. This allowed testing of control, 1X, 5X, and 25X (0, 10, 20, 100 lb/A VOLAK).

Each pen contained a water supply, a shelter and was stocked wth 1 male and 5 female pheasants.

The pens were placed side by side with tarpaper between the pens to avoid visual contact between groups of birds.

Birds were fed pre-formulated rations called "Starting and Growing (Z-1) Medicated and Game Bird Starter and Grower Medicated." Both contained a Vitamin K complex which is the antidote to this toxicant.

Results

Due to unexplained handling, fighting, and control mortality the results suggest that further modifications should be studied with the VOLAK pellet to possibly reduce pheasant palatability and mortality.

Reviewer's Conclusion

Category: Invalid

Rationale: Due to the multiplicity of mortality, this study cannot be considered useful to support the orchard use of brodifacoum.

Repairability: None

DATA EVALUATION RECORD

1. CHEMICAL: Brodifacoum

2. FORMULATION: Probably 0.001%

3. CITATION: Merson, M.H. and R.E. Byers. (1983) Evaluation of Brodifacoum Residues in Voles and Non-target Animals From the 1981 Secondary Poisoning Study, Acc. #250077.

4. REVIEWED BY: Russel Farringer
Wildlife Biologist
EEB/HED

5. DATE REVIEWED: 7/28/83

6. TEST TYPE: Residue analysis of target and non-target species.

   Test Species: Numerous. See results section.

7. REPORTED RESULTS: (See results section)

8. REVIEWER'S CONCLUSIONS: See discussion under "Reviewer Evaluation."

Materials/Methods

Test Procedure

Collect samples of target species pre- and post-treatment for residue analysis.

Collect dead non-targets post-treatment.

Determine efficacy by mark-recapture trapping.

Results (from report)

Pine Voles

Brodifacoum residues in 8 of 9 pine voles trapped pre-treatment were below the lower limit of detection of the analytical procedure (0.10 ppm). The one vole with a detectable limit had a residue of 0.24 ppm.

Brodifacoum residues were significantly greater ($p < .05$) in pine voles trapped 1 or 3 days post-treatment than in voles pre-treatment. Voles trapped 1, 3 or 10 days post-treatment had no significant difference in residue levels. Residue levels of the trapped pine voles post-treatment ranged from <0.10 to 1.86 ppm.

Residues of Brodifacoum in pine voles found dead during ground searches ranged from <0.10 ppm to 1.76 ppm. No significant differences in residues were found between voles found 4, 5, or 6 days post-treatment (Kruskal-Wallis, H' = 2.799, p <.05) or between pine voles found dead and those trapped post-treatment (Wilcoxin Rank-Sum test, W* = -0.03, p <.05).

Meadow Voles

One of three meadow voles trapped pre-treatment contained 0.15 ppm brodifacoum. The remaining two were <0.10 ppm. No explanaton for this residue can be given.

Residue levels post-treatment for trapped animals ranged from 0.30 to 1.00 ppm and for those found dead, 0.22 to 2.08 ppm (respective means 0.57 $\pm$ 0.30 and 0.89 $\pm$ 0.74).

Non-Target Specimens

Four of seven song birds found dead by Winchester Fruit Research Laboratory (WFRL) personnel during the post-treatment ground searches contained detectable brodifacoum residues (range from <0.10 to 0.55 ppm). Dark eyed Junco's represented over half the birds found.

Brodifacoum residues in white-footed mice found 6 and 9 days post-treatment contained 7.00 and 3.58 ppm brodifacoum, respectively.

Summary

In general, the level and extent of brodifacoum contamination of the vole population observed in this study agrees with observations made in the 1980 study; that is, nearly complete throughout the entire population (85-90%) and averaging less than 1 ppm. Brodifacoum is implicated in the mortality of some of the songbirds found.

Reviewer's Evaluation

1. If, as these researchers report, brodifacoum was not used in the area where the pre-treatment pine and meadow voles containing residues were collected, then does not the anlaytical method produce false positives? If the analytical method produces false positives, then it is possible that false negatives also occur.

2. The actual amount of time spent in the field searching and the total area covered would have to be provided in order to ascertain the usefulness of this study in regards to expected non-target mortality under operational control.

3. On the field searches for dead animals, it appears that an insufficient number of days were covered. Indications

(other studies) are that the latency period for brodifacoum can extend for several months. The reseacher's longest period of time post-treatment was 10 days (voles).

Category: Invalid

Rationale: See above

Repairability: None

DATA EVALUATION RECORD

1. CHEMICAL: Brodifacoum

2. FORMULATION: 0.005% GFU 088

3. CITATION: Brodifacoum Residues in Screech Owls and Other Wildlife from Volid®-Treated Apple Orchards. (1983) ICI Americas, Inc. Acc#250077.

4. REVIEWED BY: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. DATE REVIEWED: 7/29/83

6. TEST TYPE: Tissue analysis

   Test Species: (See results section next page)

7. REPORTED RESULTS: (Next page)

8. REVIEWER'S CONCLUSIONS:

   EEB believes that the residue analysis techniques may be deficient in regards to the tissues analyzed versus the spiked tissue used as a base-line standard. In addition, false positives seem to occur without an explanation. EEB defers to Residue Chemistry Branch for this study. Residue Chemistry will need, in addition to this study, a complete detailed report of ICI Americas, Inc. Method Gram 2/1 and in detail all of Analytical Bio-Chemistry Laboratories' modifications of the Gram 2/1 method.

Materials and Methods

Study Procedure

1. Collect dead animals in the study area.
2. Return specimens to lab frozen.
3. Take tissue sample for HPLC analysis.
4. Necropsy dead animals.

Results

The limit of determination was 0.3 ppm for the bird livers and 0.1 ppm for all other samples.

	Species or Sample	Number Collected/ Number with Residue	Residue Range (ppm)
1.	Screech owl liver	19/9	0.3 to 8
2.	Long ear owl liver	1/1	0.3
3.	Owl carcass	23/0	Not detectable
4.	Owl pellets	14/2	0.42, 0.24
5.	Mice and voles	63/63	<0.1 to 7.0 (mean. 72)
6.	Quail livers	3/1	0.6
7.	Junco	12/7	0.14 to 0.62
8.	Song sparrow	1/1	0.22
9.	Cottontail rabbits carcass	19/0	Not detectable
10.	Cottontail rabbits livers	5/2	0.3, 0.2
11.	Whitetail deer (rumen and liver)	1/0	Not detectable
12.	Fox	1/0	Not detectable

Reviewer's Evaluation

1. The analyzing lab (Analytical Bio-chemistry Laboratories, Inc.) indicates that the deer liver had 0.1 ppm brodifacoum level (letter of June 2, 1982). In a letter from the same laboratory dated August 13, 1983, they refute their findings on the deer liver. The June 2, 1982 letter indicates that the extraction technique was standardized against chicken livers with known concentration levels. The August 13, 1983 letter indicates that recoveries were determined using lean ground sirloin steak. This reviewer questions the validity of using ground sirloin steak as a reference for liver samples. If the technique for extraction from chicken livers was not adequate, how then can the extract from livers of targets and non-targets be accurate?

2. The mean residue level for mice and voles is not accurate in that it reflects the residues found in 44 animals divided by 66 samples. The mean appears to be around 1.03 ppm.

3. The complete analysis techniques used in this report and all related material should be sent to Residue Chemistry Branch/HED for validation with a copy of their review forwarded to EEB/HED.

Category: Probably invalid

Rationale: Analysis techniques and recovery appear faulty.

Repairability: Study deferred to Residue Chemistry Branch for validation.

DATA EVALUATION RECORD

1. CHEMICAL: Brodifacoum

2. FORMULATION: None

3. CITATION: Morris, K.D. (1983) Analysis of Screech Owl Mortality as Revealed by Banding Studies. ICI Americas, Inc., Acc#250077.

4. REVIEWED BY: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. DATE REVIEWED: 8/5/83

6. TEST TYPE: Banding review mortality

   Test Species: Screech owl

7. REPORTED RESULTS: There are many causes of screech owl mortality. "The main point to consider is that banding results are highly biased."

8. REVIEWER'S CONCLUSIONS: If bird banding is highly biased, (and EEB believes that it is for the uses present in the text) the extrapolation of data from a highly biased source would force any conclusions reached in regards to mortality and causes of that mortality, also to be highly biased.

DATA EVALUATION RECORD

1. CHEMICAL: Brodifacoum

2. FORMULATION: None

3. CITATION: Morris, K.D. (1983) Literature Review of the Population Biology of Screech Owls and Other Birds. ICI Americas, Inc.

4. REVIEWED BY: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. DATE REVIEWED: 8/5/83

6. TEST TYPE: Literature review

   Test Species:

7. REPORTED RESULTS:

8. REVIEWER'S CONCLUSIONS: Secondary source.

DATA EVALUATION RECORD

1. CHEMICAL: Brodifacoum

2. FORMULATION: N/A

3. CITATION: North, P.M. (1983) A Complete Modelling Study of the Population Dynamics of the Screech Owl (Otus Asio). Applied Statistics Research Unit, the Mathematical Institute, University of Kent, Canterbury, Kent CT2 7NF, U.K. Acc#250077

4. REVIEWED BY: Russel Farringer
   Wildlife Biologist
   EEB/HED

5. DATE REVIEWED: 8/9/83

6. TEST TYPE: Computer model

   Test Species: Screech owls

7. REPORTED RESULTS: There are 136 tables and figures in the Appendix of this report that states the results of modifying various parameters of the computer program. They are not included in this review.

8. REVIEWER'S CONCLUSIONS: (See following discussion)

   From Dr. P.M. North's paper (some direct quotes; some editorial)

A. "The aim of this study is to investigate the effects on populations of screech owls of increasing their mortality rates."

B. Background for the model is provided by the Van Camp and Henny (1975) work in Northern Ohio. "The estimated population parameters presented in the paper will form the basis of the modelling approaches described in later sections of this report. Associated problems with these estimates are also discussed later."

   "Despite the extent of the Van Camp and Henny study, the information given only really provides a summary of the owl's population dynamics. Consequently, the modelling approaches necessarily have to be kept fairly simple, and should be viewed simply as a means of giving an indication, to an order of magnitude only, about the inter-relationship between population parameters under disturbance of the mortality rates. Specifically we shall be interested in how, and to what extent, various population parameters might have to change in order to maintain a stable population, when mortality rates are increased."

C. Van Camp and Henny (1975) suggest that between 77% and 83% of the one-year-old birds may breed (based on very small sample size). "To simplify matters, as a start we will follow Van Camp and Henny (1975) and assume that all first year birds do breed. These authors use only a first year survival rate and a constant annual survival rate for second year and older birds. They obtain estimates for these rates from a ringing (banding) study reported on page 34. These estimates, and the procedure used to obtain them, prompt a number of comments relative to the present study."

D. "These estimates are obtained for (and from) screech owls ringed as nestlings and adults in the Northeastern United States and Ontario, whereas the study area for the detailed screech owl work (Van Camp and Henny, 1975) was in Northern Ohio. Furthermore, the birds were ringed in the period 1915-1964, whilst the main study was carried out only in the years 1944-1973. This means that when we come to try to model the population rates in this report, we have at our disposal only estimates of population parameters from different populations of birds, thus complicating any attempt to apply them to a single population."

E. "In arriving at the survival estimates, the annual adult mortality rate is assumed to be constant throughout the 50-year period 1915-1964. But is quite possible that the mortality patterns of screech owls have changed over this period.... Further, the estimates are given without any indication of precision. That is, point estimates only are given, without any indication of their standard errors (and this applied to all the estimates given in the Van Camp and Henny paper). This is relevant when we come to consider perturbations of the population parameters in the later sections of this report. The perturbations need to be viewed against a background of unknown degree of variability in the parameter estimates provided."

F. "The figues given by Van Camp and Henny (1975) concerning ringing recoveries enable us to estimate the second year mortality rate from a very small sample as 13/32 = 0.406. This would indicate that rather higher recruitment rates than we prescribed in Table 1 would be required for stability if there is a higher second year mortality rate."

Reviewer's Conclusions

While the above group of statements (A-E) were extracted from the report, there were additional statements that could be used in determining the validity of this model in relationship to Hegdal, et al. (1983) report. However, the following discussion of the above material should be indicative of why the model is inadequate without detailing each and every point.

Points in regards to A.

This statement indicates a clear and concise purpose. The rest of the study, due to the assumptions, tends to be highly speculative and theoretical without a sound basis for construction of the model in regards to the data at hand.

Points in regards to B.

Van Camp and Henny's (1975) paper is the source for population parameters. As pointed out by Dr. P.M. North, there are problems with these population estimates. The estimates are only summaries of the data collected. The data do not have confidence intervals or ranges that would allow for interpolation of the specific parameter data point given in Van Camp and Henny's paper. Thus, the range and/or confidence interval could lie from a very narrow (less than a order of magnitude) to very large (several orders of magnitude) span. The "single model" may have a very large error factor if the data has one or more orders of magnitude associated with it, especially when the formulae multiply these errors together. Therefore, Dr. North's indication that the fairly simple model "should be viewed simply as a means of giving an indication, to an order of magnitude..." appears unsubstantiated in relationship to the parameters of the population.

Points in regards to C.

This discusses the probability of one-year-old birds breeding. Van Camp and Henny suggest that between 77% and 83% of the one-year-old birds may breed but this is based on a small sample size. Dr. North followed Van Camp and Henny's lead and assumed that 100% of the first year birds breed. As long as the data for other breeding parameters were assumed usable, why then was the computer program not designed to handle 77%, 83% and 100%? The 77% and 83% values could be realistic, if one assumes that late nesting attempts of the previous year fledged individuals were not capable of breeding due to lack of maturity.

Points in regards to D.

The assumption that the use of disjunct temporal and spatial data is valid without a quantative analysis of whether the data is applicable, would indicate that any parameters cited in the literature could be used. Further, banding (ringing) data is not without bias.

Points in regards to E.

The assumption is made that survival estimates are constant. However, what if these survival estimatse have no statistically acceptable basis? This is another assumption that has to be accepted at face value without the benefit of determining the validity of the given data point, the range, or confidence intervals.

Points in regards to F.

Our final concern is with the source for the figure "13/32 = 0.406." We are assuming that this figure is based on the data in Hegdal et al. (1983). We assume that the 32 is based on the 38 screech owls that were banded in the study areas minus the five that were not accountable as of the first day of treatment and the one bird which was alive at the end of the treatment period. The 13 is proably based on the seven birds found dead and the six birds that were collected.

Since the discussion here is centered around second year mortality and Dr. North had to make assumptions beyond the reliable scope of the data the following assumptions are considered as valid as the ones he derived.

Assumption #1. Based on Van Camp and Henny (pg 19) the birds in the study area in late fall and winter should be primarily breeders for the following season, and sedentary.

Assumption #2. The sampling of screech owl populations in the study area (Hedgal, et al., 1983) was complete.

Example #1

First, the sample population was 38 not 32 over the approximate four months of the study.

Second, only one bird was known to be alive at the end of the study.

Thus, the formula factors for survivalibity is 37 unaccounted for out of 38 birds.

37/38 = .974 survivability factor.

This can be refuted because 17 of the birds could not be accounted for due to lack of radio transmission reception.

However, if one considers that only 2.6% of the population would be available for capture during the next breeding season then the Hegdal, et al. (1983) report of capturing only one screech owl during the breeding season is not without basis.

Example #2

First, the sample population is only the birds dead or alive at the end of the four month study. This equates to 21 birds.

Second, only one bird is known to be alive at the end of the study (January).

Thus, the formula becomes

20 dead/21 accountable = .952

This would indicate that 4.8% of the original population was available for sampling in May. Again, only one of the 21 birds would be captured which follows Hegdal's report.

Example #3

Now assume that Dr. North's use of 13 is based upon 13 owls dying from brodifacoum application; and that the total accountable bird population is 21 as in Example #2. Using the same formula 13/21 we get .619 which means that 38.1% of the population is left. Of this 38.1% we know one is still alive and seven are dead (various causes). One out of eight equates to 12.5% with seven out of eight equating to 87.5%. If we multiply the 38.1% of the remaining population by the 87.5% of the known dead in that population, we arrive at 33.34% adult mortality rate. This 33.34% adult mortality rate appears comparable to the expected mortality rate stated by Van Camp and Henny.

Conclusions:

Category: Invalid

Rationale: This compóuter program was based on assumptions that could not be statistically verified. The field data that was collected by Hegdal, et al., was not properly perceived thus incorrectly used in the model.

Repairability: If the program parameters and/or assumptions could be substantiated and if the Hegdal field data was used as a basis for the population mode then this study may be repaired. However, unless there is more data than what was presented in Hegdal, et al., this repair will be impossible.

DATA EVALUATION RECORD

1. Chemical: Brodifacoum.

2. Formulation: 10 ppm brodifacoum (?)

3. Citation: Hegdal, Paul L., Bruce A. Colvin, Raymond W. Blaskiewiez, and Thomas A. Schoenberg (1983). Secondary Hazards to Screech Owls Associated with the Use of Volid (Brodifacoum Bait) for Controlling Voles in Orchards. Draft Report. Draft report under a cooperative agreement between ICI Americas Inc., and the U.S. Fish and Wildlife Service. Funds to conduct the study were provided by ICI Americas Inc. Acc#250077.

4. Reviewed by: Russel Farringer
Wildlife Biologist
EEB/HED

5. Date Reviewed: July 28th, 29th, August 1, 2, 1983

6. Test Type: Secondary hazards to Screech Owls from brodifacoum use in orchards.

7. Reported Results: (Quoted from text of Report)

"In this study, a potential hazard to individual screech owls from the use of brodifacoum bait for treating orchards for voles was demonstrated. However, the problem remains of interpreting the observed hazard in light of maintaining non-target populations. Van Camp and Henny (1975) note that young screech owls have the capability of rapidly reinvading areas that may have been depopulated by catastrophes. Additionally, screech owl populations may be resilient enough to withstand an additional mortality factor such as secondary brodifacoum poisoning. Maintenance of screech owl populations associated with treated orchards, at present or some lower level, may therefore occur. However, we do not have sufficient data to address the significance of the observed mortalities and population turnover to maintaining screech owl populations that are associated with brodifacoum-treated orchards over time."

Reviewer Conclusion: (See end of review).

Material/Methods

Study Procedure (All quoted material from report.)

Study Duration: Fall and winter 1981-1982 (25th October 1981 to 22 January 1982) Post study survey- Spring 1982 (May).

Study Area: Fifteen specific study sites (treated orchard areas) in the Shenandoah Valley near Winchester, Frederick County, Virginia. "This area was selected because of: (1) the relatively high concentration of apple orchards, (2) the historic vole problems, (3) the presence of screech owls and other raptors, (4) the proximity of the Winchester Fruit Research Laboratory (sic) (WFRL), and (5) the assistance of Mark H. Merson and Ross E. Byers of the WFRL." Actual study site selections were based on 3 criteria: "(1) to maximize the possible presence of screech owls, the orchard must adjoin a woodlot at least on one side, (2) the orchard must contain a vole population adequate to justify treatment, and (3) the orchardist must agree to the experimental brodifacoum treatment."

Nest boxes: A total of 144 nest boxes were placed in the selected sites. These were to be used to help capture screech owls.

Treatment: Treatments were started "9 November 1981 and ended on 12 January 1982, orchards were treated with VOLID bait by WFRL personnel in accordance with an EPA Experimental Use Permit (EUP) No. 10182-EUP-21. VOLID bait containing 0.001% brodifacoum was broadcast with ground equipment at a rate of 16.8 kg/ha (15 lbs/acre). This is equivalent to 168 mg (active ingredient) of brodifacoum per hr. In addition, several orchards were treated with VOLID at 11.2 kg/ha (10 lbs/acre) by the orchardists under an experimental use permit. Furthermore, other registered rodenticide baits containing zinc phosphide and the anticoagulent ROZOL (containing chlorophacinone) were used on nearby orchards. However, our efforts were concentrated on the brodifacoum-treated orchards; a few of which also were treated with zinc phosphide."

Owl Capture Techniques

1. Capture from nest boxes.

2. Mist nets (10.2 cm mesh) with recorded calls

3. Verbail traps on poles with tethered or caged animals placed near the trap.

4. Swedish goshawk traps with rock dove baits and recorded calls.

5. Bow net trap designed by G. Corner baited with caged rats, mice, or rock doves.

Radiotelemetry

"Radio transmitters used in this study were designed and built by the Bioelectronics Unit, Section of Supporting Sciences, Denver Wildlife Research Center. They were in the 164 MH band on the 12 USFWS assigned channels. All transmitters were designed to be attached to the central tail feathers by the hot melt glue technique (Fitzner and Fitzner 1977, Bruggers et al. 1981)."

Mortality (2 pulse) and single pulse transmitters were used.

Once the study was under way, the researchers tried to locate the owls' roosting sites during the day and feeding sites at night on a daily basis.

"All figures illustrating movements of radioequipped owls were constructed by connecting (with a straight line) consecutive points where the bird was located by radio telemetry."

Necropsy and Residue Analysis

"All screech owls and other animals that were found dead or collected were labeled, individually packaged in plastic bags, and frozen for necropsy and residue analysis. Likewise, other animal tissues were collected and owl pellets were maintained frozen for later residue analysis. All carcasses were assigned random numbers by field personnel and were necropsied and analyzed for chemical residues as unknowns."

Necropsies of birds and cottontail rabbits were conducted by Paul L. Hegdal (USFWS) (17 February 1982) with assistance from ICI personnel at Goldsboro, N.C.

"Residue analyses were conducted by Analytical Biochemistry Laboratories, Inc. Columbia, Missouri using the ICI Americas Inc. Method GRAM-2/1, an HPLC Method for the Determination of Brodifacoum in Animal Tissue..... The limit of brodifacoum determination was 0.3 ppm for bird and rabbit livers and 0.1 ppm for all other samples."

See Ussary (1983) report - DER and Acc#250077 Study 10I.

Results

Thirty-eight screech owls, 5 barred owls, 3 red-tailed hawks, 2 great horned owls, 2 long-eared owls were captured and radioequipped. Twenty-one other raptors were captured but were not radio-equipped.

Color phase of screech owls captured: 19 gray, 18 red, 1 brown (fall 1981); 6 gray, 3 red spring 1982.

"Prior to treatment (and for various reasons) 5 screech owls (Nos. 1-5) were no longer part of our radio-equipped population...Therefore, only 33 of the radio-equipped screech owls were potentially exposed to brodifacoum."

"During the study, 7 radio-equipped, and intact, screech owls (Nos. 6-12) were found dead."

"The remains of 4 screech owls (Nos. 13-16) were found post-treatment after they had been mostly consumed by an avian predator. In each instance, there was no carcass available for necropsy or brodifacoum residue analysis."

"We used three principal criteria to evaluate the relationship between the observed mortalities and possible secondary brodifacoum poisoning. These criteria and their components were:

1. Radiotelemetry
   a. Treated area included in total home range.
   b. Treated area included in home range 2 weeks posttreatment.
   c. Tracked in treated area posttreatment.
2. Necropsy
   a. Presence or lack of hemorrhaging.
   b. General physical condition.
3. Residue - Residue present in liver or carcass.

Other information was used only when available and included residue analysis of pellets, field observations, and reports by others."

"Each of these criteria was considered independently and then collectively as to information supportive or non-supportive of possible secondary brodifacoum poisoning. A value was then assigned on a scale of 1 to 5 as to confidence of brodifacoum secondary poisoning (5 being most confident). Values for owls Nos. 6-11 ranged from 3.5 to 5, owl No. 12 was 1 and insufficient data was available to assign values to owls Nos. 13-16 which had been mostly consumed by avian predators (Table 6). Secondary poisoning because of brodifacoum was, therefore, stated as the most probable cause of death for owls Nos. 6-11 (Table 3)."

"During early January, 1982, (between 34 and 57 days posttreatment) 6 of the radio-equipped screech owls (Nos. 17-22) were collected for residue analysis. Only 6 were collected because we planned to return in May 1982 to check nest boxes and attempt to capture any of the previously radio-equipped screech owls present in the study area. These 6 birds appeared alert and normal when captured... Four of these birds contained brodifacoum residue in the liver ranging from 0.3 to 0.6 ppm (Table 5)."

"Of the 16 screech owls not previously discussed, 12 (Nos. 23-34) lost their transmitter (along with the central tail feathers) between 3 and 55 days posttreatment, and we lost radio contact with another 3 (Nos. 35-37) posttreatment (Table 3). At least 11 of these 15 birds were located in treat areas posttreatment. The remaining owl (No. 38) was still carrying an operating transmitter on the last date we radio-tracked, 22 January 1982, 63 days posttreatment (Fig. 40)."

"Mean home range, based on owls that were radio-tracked for 10 or more days, was 109.1 $\pm$ 82.9 ha (Table 7)."

<u>Other Raptors</u>

1. 5 barred owls - 4 limited use of treated orchards
   1 lost contact before treatment
   No deaths
   3 tracked through termination of study

2. 2 great horned owls - Lost radio contact with both
   1-day of treatment, 1-8 days post-treatment
   Presumed transmitter damage

3. 2 long-eared owls, - 3 red tail hawks — Lost contact with all 5 within 5 days of treatment

"On 5 January 1982, we were informed that a cooperator had found a dead long-eared owl about 20 December 1981 near his residence, less than 100 m from a brodifacoum-treated orchard. We also collected several pellets from the farmstead where 2 long-eared owls had been roosting. The cooperator reported that "the dead owl had hemorrhaged -- apparently from the head -- when found dead." Severe hemorrhage was noted in the necropsy (sample No. 8, Table 5). Residue analysis of 5 samples of the collected pellets showed that 1 contained 0.42 brodifacoum and 4 had no detectable residue. As we did for screech owls, we considered the criteria for possible brodifacoum poisoning, and assigned a confidence index value of 3.5 (scale 1 to 5) that secondary poisoning from brodifacoum was the probable cause of death."

<u>Other Non-target Wildlife</u>

1. 5 bobwhite quail - Of those analyzed only one pretreatment quail had a detectable level (0.6 ppm) of brodifacoum in the liver.

2. 1 pileated woodpecker - No detectable levels in carcass or liver.

3. 3 downy wood peckers - No detectable levels in the carcasses.

4. 1 hairy woodpecker - No detectable levels in the carcass.

5. 7 dark-eyed juncos - 4 had detectable levels (0.14, 0.18, 0.62, 0.35 ppm) in their carcasses. Livers not analyzed.

6. 3 white-throated-sparrows, 2 fox sparrows, 3 cardinals, 1 mourning Dove, 1 blue jay, 1 American robin — No detectable levels in carcasses. Liver not analyzed.

7. 7 cottontail rabbits - Pretreatment: No detectable levels in all carcasses. One liver analyzed with no detectable level.

8. 10 cottontail rabbits - Posttreatment: None of the carcasses had detectable levels, 4 livers were analyzed with two containing 0.2 and 0.3 ppm and two not detectable level.

9. 1 white-tailed deer - Rumen and liver analysis did not detect any brodifacoum residue.

Reviewer's Evaluation

The primary objective for this study was to collect definitive data on the potential secondary hazard to screech owls and great horned owls when brodifacoum (Volid, 0.001%) was utilized for vole control in apple orchards. In addition, incidental mortality to other non-targets was to be recorded with samples collected for verification by chemical analysis of tissues (muscle and liver).

Screech Owls

Over the course of the study (Late October 1981 to 22 January 1982), thirty-eight screech owls were radio-tagged. Of the 38 owls, only 18 owls could be accounted for on Jan. 22, 1982. Of these 18 owls only one was still alive. (Table 1.)

Four birds (Nos. 13 to 16 inclusive) were killed or presumed killed by predators, six birds (Nos. 17 to 22 inclusive) were collected and seven birds were found dead (Nos. 6 to 12 inclusive). Of these last seven birds, one died of unknown causes and the other six were "apparent secondary poisoning by brodifacoum." Table 2 depicts the potential exposure time of the birds found dead or collected in relationship to post-treatment time.

The researchers indicated that they determined the likelihood of brodifacoum poisoning by using a confidence index of various factors to arrive at a value between 1 and 5 which determined a certainty level that an owl died from brodifacoum poisoning. However, they did not delineate the ranking factors nor the respective values for these factors; therefore it was not possible to determine the validity or value to the report of the "Index value."

Problems and Questions

A. The researchers state that VOLID, a 0.001% brodifacoum bait, was used. This is the percentage of active ingredient that the bait was supposed to contain. The researchers cite Ussary's (1983) residue analysis work for animal tissues. Ussary's work has an "authentication" page dated 2/21/83 which states, "We, the undersigned, hereby declare that this study was performed under our supervision according to the procedures described, and that this report represents a true and accurate record of the results obtained." The signatures that follow are: Dale Kaukeinan (Study director), James P. Ussary (Manager of Residue Chemistry) and Frederick J. Pearson (Residue Chemist). Under "Description of trial and samples," first paragraph, second sentence, the following statement appears: "Approximately 500 acres of apple orchards were treated by Winchester Fruit Lab (Virginia Polytechnic and State University) Staff with single broadcast application of 15 pounds per acre of VOLID formulation GUF 088 containing 50 ppm brodifacoum."

1. What was the percentage of active ingredient used in the Hegdal, et al. study of screech owls in Frederick County, Va?

2. The Hegdal, et al. report indicates that for screech owl study sites, 5 of the sites received 3 treatments: How many treatments of brodifacoum bait were made at each of the screech owl study sites? What is the date of each application? What is the application rate for each application? What method of application was used with each treatment?

3. What are the physical properties and chemical analysis of GFU 088 and any other brodifacoum pellets used within the entire study area?

4. Both Hegdal, et al., and Ussary indicate that more than 500 acres were treated in close proximity to the study sites. How many acres were treated with brodifacoum in Frederick County, Va. from January 1, 1981 to May, 1982? What specific amounts were applied per month (with determination of the distance from the closest screech owl or raptor study site)?

B. This study was to be a definitive research project in which VOLID applications were to be compared against the non-target mortality of raptors (primarily screech owls). Treatments in the study areas consisted of: (1) only VOLID - 2 sites; (2) VOLID and zinc phosphide - 9 sites; (3) VOLID, zinc phosphide, rozol (chlorophacinone) - 2 sites; (4) only zinc phosphide - 1 site. (These values are for all owl study sites).

While these multiple pesticide applications with multiple chemicals were not the responsibility of the researchers for this report, EEB is concerned with this dilemma as the results of the study are inconclusive.

1. Owl #6 was found dead in a zinc phosphide treated orchard with two regurgitated voles nearby. Its home range, based on the radio-tracking figure (No. 8), include orchards treated with zinc phosphide and brodifacoum. Table 3 of the report indicates apparent brodifacoum poisoning. Table 6 gives a confidence index value of 3 to this owl. The residue analysis for brodifacoum gave no detectable levels for both the carcass and liver. With this background the following questions arise:

   Is brodifacoum an emetic? Were the two regurgitated vole analyzed for brodifacoum or stomach contents determined? Is it possible that this owl died of zinc phosphide poisoning? Could there have been a synergetic effect between the two toxicants?

2. The confidence index is based, to some unknown extent, on the residue analysis of the tissues (muscle and livers). However, the residue analysis was only for brodifacoum (cis-, trans-) and did not include analyses for the other two toxicants where exposure potential was possible. Eight out of twelve of the screech owls that were analyzed for brodifacoum were exposed to two or more rodenticides.

Questions:

Was there a synergetic effect where the owls were exposed to more than one rodenticide? Could the number of screech owls that were determined to have been killed by brodifacoum poisoning be reduced by indicating the involvement of other rodenticides?

C. On January 22, 1982, the researchers had completed removal of all trackable screech owls. At that time there was a potential for 18 screech owls to still be in the area. The citation, Van Camp (1975), indicates that at the time of year, this study was conducted while 25% of the screech owls might be young-of-year, 75% mature owls and that the adult birds are sedentary. The radio-telemetry study indicates that the majority of the owls remained in the area trapped. During May, 1982 a trapping effort of unknown duration was conducted. Only one of the potential 18 birds was captured.

From this information it would appear that a significant population reduction occurred. However, this cannot be ascertained with any degree of certainty due to the following reasons:

1. The units of trapping effort pre- and during treatment and in May 1982 are not given;

2. The age-class of the screech owls was not determined; and

3. The effects of weather stress, prey base removal, and other factors cannot be quantified.

Conclusions:

EEB has reviewed Hegdal, et al., 1983 Draft Report. EEB does not believe that the data is conclusive due to reasons given above. The conclusions that we ascertained from the report are: 13 owls (posttreatment and non-predation) were accounted for at the end of the study of which 9 to 10 may have died or been destined to die from secondary poisoning. This could indicate that 69% to 77% of the resident (probably adult) screech owls were killed by secondary poisoning. This would be a significant population reduction.

Table 1. Summary of Screech Owl Data.

Owl No.	Status as of Jan 22, 1983	Cause of Death	Residue (ppm) Carcass	Residue (ppm) Liver	Orchard Treatment
1	Dead	Vehicle	No	No	NX[5]
2	Dead	Vehicle	No	No	NX[5]
3	Lost contact[1]	-	-	-	-
4	Dead	Predation	No	No	NX[5]
5	Lost contact	-	-	-	-
6	Dead	Secondary[2]	No	No	V + ZnP[6]
7	Dead	Secondary	No	0.8	V + ZnP
8	Dead	Secondary	No	0.5	V + ZnP
9	Dead	Secondary	No	0.5	V
10	Dead	Secondary	LA	0.5	V + ZnP
11	Dead	Predation/ secondary	LA	0.4	V + ZnP
12	Dead	Unknown	No	No	V[7]
13	Dead	Predation	-	-	-
14	Dead	Predation	-	-	-
15	Dead	Predation	-	-	-
16	Dead	Predation	-	-	-
17	Dead	Collected[3]	No	No	V

18	Dead	Collected	No	No	V, ZnP
19	Dead	Collected	No	0.6	V, ZnP, RZ
20	Dead	Collected	No	0.3	V
21	Dead	Collected	No	0.4	V
22	Dead	Collected	No	0.3	V, ZnP
23	Lost contact	-	-	-	-
24	Lost contact	-	-	-	-
25	Lost contact	-	-	-	-
26	Lost contact	-	-	-	-
27	Lost contact	-	-	-	-
28	Lost contact	-	-	-	-
29	Lost contact	-	-	-	-
30	Lost contact	-	-	-	-
31	Lost contact	-	-	-	-
32	Lost contact	-	-	-	-
33	Lost contact	-	-	-	-
34	Lost contact	-	-	-	-
35	Lost contact	-	-	-	-
36	Lost contact	-	-	-	-
37	Lost contact[4]	-	-	-	-
38	Alive	-	-	-	-

1. Lost contact = Molted tail feathers and transmitter, lost radio contact reason unknown.

2. Secondary = Secondary poisoning probable.

3. Collected = Researchers removed from study site for analysis.

4. Owl-37 was found alive in a nest box in May 1982.

5. NX - Not exposed

6. V = Volid, ZnP = Zinc Phosphide, RZ = ROZOL

7. Owl - 12 apparently flew over the treated orchard on one or two occasions.

8. No = Not detected LA = Lost in analysis, (-) not analyzed.

Table 2. Duration of Exposure of Screech Owl

Owl No.	Date of Application[1]	Date Bird Found Dead or Collected	No. Days Post-treatment
6[2]	11/17	11/22	5
7	11/9, 11/27-30	12/2	23,2
8	11/17	12/21	34
9	11/29	12/12	13
10	11/17	12/18	31
11	12/4	12/22	18
12[2]	11/16	12/23	37
17[2]	12/3	1/6	34
18	11/18	1/9	52
19	11/30	1/12	43
20[2]	11/18	1/9	52
21	11/16	1/12	57
22	11/9, 11/27-30	1/4	56, 35

1. This is the date(s) of the treatment to which the owl could be exposed. In some cases additional treatments were made after the mortality occurred.

2. Owls not located in treated area post-treatment.

Conclusions:

Category: Invalid

Rationale: More than one rodenticide was used in the home range of the owls. The subsequent tissue analysis did not test for these additional toxicants. Will not support registration.

Repairability: None

Category: Supplemental

Rationale: Sample size (N=5) is too small. Mortality among these 5 exposed to VOLID was extremely high. The result may or may not be indicative of the actual field use.

Repairability: If the registrant is willing to accept that only 5 birds were representative of the total population, then this study could be made Core. The results would then be 60 to 80% of the raptor population was effectively removed by the use of VOLID. 3 month period

Category: Core

Rationale: This study could be considered core if the original hypothesis were changed from what are the effects of VOLID baiting in orchards to the raptor populations to what are the effects of rodenticides used in vole control in orchards. However, this second hypothesis would not support the registration of VOLID for use in orchards.

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