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The USDA APHIS WS Unified Model for Estimating DRC-1339 Bait Application Take Estimates as Effected by French Fry Bait Size

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ABSTRACT: DRC-1339 (CPTH, 3-chloro-*p*-tolouidine) is an avicide registered to reduce local populations of selected bird species at feedlots, dairies, and staging areas near rice fields, and to prevent livestock depredation. Additionally, two registrations are specifically for controlling gulls and pigeons. U.S. Department of Agriculture Wildlife Services personnel historically have used a variety of methods to estimate take, including counting carcasses and quantifying reduction in bird activity. Because this avicide is slow-acting and birds usually succumb away from the bait site, carcass recovery provides poor estimates of take. Because of natural variability in bird numbers and activity, quantifying reductions in bird activity is also a poor gauge of efficacy. Scientists at the U.S. Department of Agriculture APHIS Wildlife Services National Wildlife Research Center developed and continue to adapt and refine a model using a bioenergetics approach to estimate consumption and the resulting mortality from DRC-1339 bait consumption. The model estimates take for the major baits used under the feedlot and staging area labels for European starlings, blackbirds, brown-headed cowbirds, and common grackles. Consumption of homogeneous baits (rice, cracked corn, fat pellets) has been well characterized, and take (i.e., mortality) is accurately predicted in the model. However, predictions of take when french fries were used as a bait for controlling starlings at feedlots in Washington State were less accurate. Thus, we modified the model to capture the feeding behavior of birds using this highly heterogeneous bait by removing the dependence on bait mass and simplifying the calculation of dose ingested. The modified model calculates dose directly from the amount of DRC-1339 per calorie consumed instead of from the DRC-1339 concentration per bait consumed. In this paper, we compare estimates of take based on french fry bait mass distributions and caloric contents determined for five different french fry bait types.

KEY WORDS: 3-chloro-*p*-tolouidine, *Agelaius phoeniceus*, bioenergetics, DRC-1339, European starlings, grackles, model, *Molthus ater*, mortality, probit analysis, red-winged blackbirds, *Sturnus vulgaris*

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INTRODUCTION

The compound DRC-1339 (3-chloro-*p*-toluidine hydrochloride, CPTH) is the only registered avicide registered for use to control nuisance bird species in the United States. This avicide is registered for use only by trained U.S. Department of Agriculture APHIS Wildlife Services personnel. The majority of DRC-1339 bait used is applied under the DRC-1339 Feedlot (EPA Reg. No. 56228-10) or DRC-1339 Staging Area (EPA Reg. No. 56228-30) labels. Baits prepared under these labels are treated with 0.2% to 2.0% DRC-1339 and further diluted with untreated bait to minimize dose for targeted birds. The avicide is slow-acting, affecting the kidneys and heart in targeted species, with mortality occurring in one to three days. Wildlife Services (WS) biologists estimate and report the number of birds taken each time they apply this avicide. However, the slow activity of DRC-1339 and resulting prolonged time to death complicate estimating mortality (Homan et al. 2001, Kosteke et al. 2001). Thus, we developed a bioenergetic, dose-response model to estimate take. Prior to the implementation of take models, pre- and post-baiting bird counts were often used to estimate take.

Early efforts to estimate dose were based on bait consumption and empirical counts of bait found in the esophagus of birds collected at baiting sites (Pipas et al. 2003). This approach used a linear regression model to predict take under the Staging Area label for red-winged black birds (*Agelaius phoeniceus*), common grackles (*Quiscalus quiscula*), and brown-headed cowbirds (*Molthus ater*) consuming rice bait, in the states of Missouri, Louisiana, and Texas. This model was officially released for use by WS personnel in 2007. Mortality was calculated as probability for the sexes of a species, based on a fixed 1:25 dilution of treated bait mixed with untreated bait.

An alternative approach developed by Johnston et al. (2007) estimated lethal dose quartiles based on LD_{50}s calculated by probit analysis. This approach was combined with a bioenergetics model component to estimate consumption to meet the caloric requirement of a bird based on thermoregulation of a core body temperature during heat and mass transfer between the bird and its environment (Campbell 1977, Campbell and Norman 1998). This model was developed to predict take under the Feedlot label for European starlings

(*Sturnus vulagaris*) using a pelleted bait and covered 20 states.

The need to increase the number of states covered under the Staging Area label model led to an effort to incorporate take estimates for both the Staging Area and Feedlot labels into a single model. This bioenergetics-based model incorporating both labels was developed and released for use by WS in 2014. The details of how feeding behavior is captured in this model are presented in Homan et al. (2011). This model is more flexible than the two previous models and allows for take estimates from mixed populations of birds, based on both sexes and multiple species. Bait dilutions are determined and input into the model by the user. The model supports take estimates for 29 states plus a general catch-all location. In addition to the species in the two previous models, take for the yellow-headed blackbird (*Xanthocephalus xanthocephalus*) is also included. The model allows as bait options the choice of french fries under the Feedlot label; rice under the Staging Area label; and cracked corn, fat pellet, and distiller's grain common under both labels. Our bioenergetics model produces lower estimates of take than the linear regression take model, reflecting differences in the way that the models capture feeding behavior (Homan et al. 2013).

The model is flexible and can be refined to further improve take estimates and incorporate new scenarios. This paper describes improvements made to the model to improve take estimates when french fries are used as the bait. The earlier versions of the model excelled at predicting take when a bait with a uniform size or mass was used. However, predictions of take using baits with a heterogeneous size/mass distribution bias model estimates of dose and impact the resulting take estimates. We modified the model to remove this effect. We demonstrate the improved take estimates for baiting operations conducted in Washington in March 2015.

METHODS

To assess the size distribution for five different fry cull materials, samples were collected during baiting operations. The material types collected included the typical french fry, potato peel, tater tots, curly fries (spiral cut), and clump material produced from cleaning the equipment used to cut and process the fries. These samples were frozen and shipped to the USDA National Wildlife Research Center for determination of mass distribution. Sub-samples were sent to the Colorado State University Soil & Plant Testing Laboratory (Fort Collins, CO) for nutritional analysis. Mass determination was done by manually separating the fries or clump aggregates and weighing them on a pan balance. Data were analyzed with the statistics program R (CRAN.R-project.org, version 3.2.3).

Evaluation of model behavior was done using climate data for a March baiting conducted near Quincy, Washington during 2015. The following climate attributes were used in the analyses: minimum daily air temperature of 30°F (-1.1°C), maximum daily air temperature of 45°F (7.2°C), wind speed ranging between 5 and 10 mph (8-16 km/h), and clear sky with no cloud cover. The different mean bait masses determined for the five french fry types were used in the model. The treated bait was formulated at 0.2% DRC-1339, and 1,000 lbs (454 kg) of treated bait were diluted with 2,000 lbs (909 kg) of untreated bait for each particular baiting operation. The mean fry mass was used to calculate the mean number of fries per kg of bait, and the corresponding mean DRC-1339 dose per fry was calculated assuming a uniform distribution of DRC-1339 at 0.2%.

The model was modified to calculate dose based on a calorie-equivalent of bait material consumed using the nutritional analysis data determined for the fries. This model was evaluated using the same parameters described above.

RESULTS

The number of fries used for the mass distribution determination of the five bait types and the corresponding mean mass calculated from them is presented in Table 1. The standard deviations for the mean are also presented and reflect the wide mass distribution for the different bait types. The number of french fries in 1 kg of bait, calculated from the mean mass and the corresponding DRC-1339 dose for a french fry, are also presented. The 10-fold range in bait mass results in a 100-fold range in DRC-1339 dose.

The calorie content determined for the five french fry bait types ranged from 4.8 kJ/g to 6.1 kJ/g and differed considerably from a calorie content of 12.9 kJ/g used to parameterize the original model. This original value was obtained in a web search and reflects the higher oil content of the completely processed french fries available through commercial outlets.

The total number of birds estimated to have visited the baiting site and the corresponding estimate for take are presented in Table 2. Bait size had a large effect on take estimates. The average caloric requirement based on the extrinsic environment for each bird was approximately 267 kJ/day. The average amount of bait consumed per bird on a calorie basis was approximately 90 kJ/bird. The average total number of fries consumed per bird corresponding to this value (Table 2) includes both treated and untreated fries.

DISCUSSION

The difference in the total number of birds visiting the bait site for the five different bait types in Table 2 result from the random generation of a bird population every time the model is run. The difference between the total number of birds visiting the five bait type scenarios and the calorie-equivalent scenario is due to the change in the calorie content of the bait. The calorie content of the baits in the five scenarios is 2.67 times that of the bait in the calorie-equivalent scenario. Thus, the total number of birds that can visit the bait site is 2.67 time the number that can visit the site in the calorie-equivalent scenario.

The bird take estimates for both models is calculated as a product of randomly generated probabilities of bait consumption calculated from 1) the amount of bait consumed per bird, and 2) the probability of mortality resulting from the dose ingested. Both models partition the bait mass into treated and untreated pools. The probability of consuming a treated bait is equal to the

Table 1. Mean summary statistics for french fry baits. The average mass and standard deviation for the different french fry baits characterized for use in the model and the CPTH dose per average mass fry have a large impact on the take estimates produced by the model. Larger french fries increase the probability of mortality following ingestion.

Type	N	Mean mass (g)	Standard deviation	Number of fries/kg	CPTH mg/fry
Fry	134	2.527	1.211	396	4.72
Peel	223	0.220	0.159	4537	0.41
Tots	42	7.849	2.016	127	14.7
Curly fries	81	3.497	4.567	286	6.54
Clump	510	0.724	1.227	1347	1.39

Table 2. Projected take for different size french fry baits for the same climate scenario in Washington. The total birds feeding at the bait pile for the two different models (fry type versus calorie-equivalent) is due to the different energy content specified in the two models per gram fry. For the five fry type simulations the energy content is 12.8 kJ/g, compared to 4.8 kJ/g in the calorie-equivalent model.

Type	Avg. fry mass (g)	Total birds	Bird Take	Avg. # of fries/bird
Fry	2.527	196,100	92,950	2.8
Peel	0.220	195,773	166,308	31.7
Tots	7.849	195,765	26,596	0.9
Curly fries	3.497	195,827	73,083	2
Clump	0.724	195,793	151,442	9.7
Calorie-equivalent	*N/A*	72,880	64,876	*N/A*

mass of the treated bait divided by the total mass of all the bait, so for these baiting scenarios the probability of eating a bait is 1/3. For starlings, the model uses an LD_{50} = 4.2 mg/kg (Eisemann et al. 2003). Using the DRC-1339 dose of 4.72 mg/french fry, the dose would likely be lethal to a bird 84.9% of the time, as calculated from the probit. A bird, randomly consuming two treated fries, each with 4.72 mg/french fry, would result in mortality probability of 96.7% as calculated from the probit. The probability of a bird eating two treated fries in this baiting scenario is possible 10% of the time.

For the five different french fry baiting scenarios, a smaller bait increases take as the probability for exposure increases with the larger number of baits consumed. Consumption of a single potato peel with 0.41 mg DRC-1339 dose results in a probit estimate of a 53.6% chance for mortality. In contrast, the calorie-equivalent take estimates are independent of bait size and are based on the 0.2% DRC-1339 on a per gram bait consumed. Again, not a lot of bait has to be consumed to present a reasonable probability that could result in mortality. For the remaining french fry types, the probability of mortality for an average massed bird ingesting a single bait are 100%, 89.5%, and 76.6%, respectively, for tater tots, curly fries, and the potato clump.

The calorie-equivalent take estimates are more representative of actual take, as the mass-based scenarios do not capture the variance in size of the fries in the bait pile. Discrete, mass-based take estimates were sensitive to the dose per fry, and the use of the average bait mass skewed take estimated with the probit due to the insensitivity of the probability-of-mortality with increasing dose. Adding a distribution around the mean mass was considered but determined to be too cumbersome as determining distributions for any given bait used would be time consuming, and a general distribution could not describe the five french fry baits evaluated.

CONCLUSIONS

The calorie-equivalent version of the DRC-1339 take model to estimate dose greatly increases the robustness of take scenario estimates. This model does not require the user to determine any particular attributes of the bait matrix being used, and it is parameterized to more accurately represent the currently-used baits. The calorie-equivalent dose estimation approach provides considerable flexibility in allowing other heterogeneously sized baits to be added to the model. The take-estimation model is a "work in progress" and can be modified as needs are identified.

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