ESTIMATING PESTICIDE RISKS TO NON-TARGET WILDLIFE USING PROBABILISTIC AND PBPK MODELS

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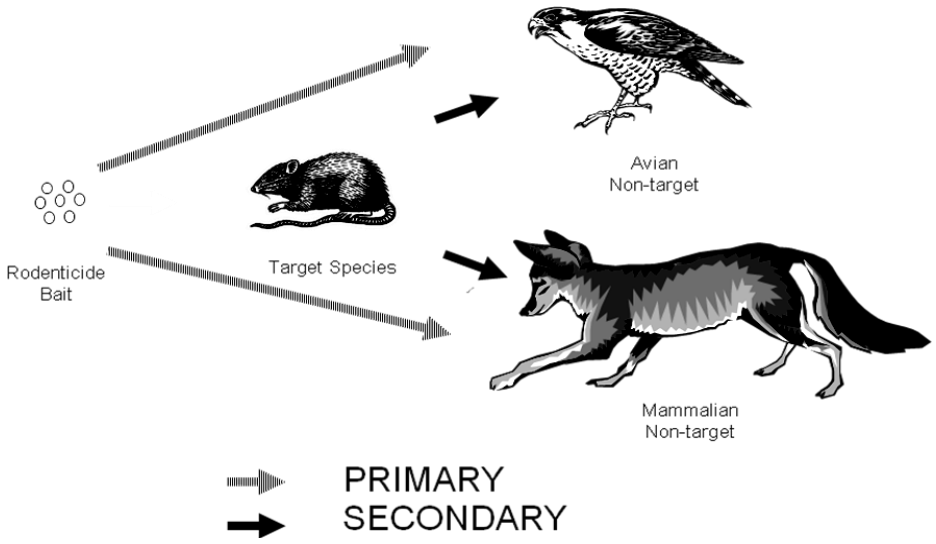
Abstract:

Successful application of pesticides requires the development of procedures which maximize efficacy towards target pest species while minimizing undesirable effects to non-target species. Probabilistic and Physiologically Based Pharmacokinetic Modeling approaches can be used estimate pesticide exposure and associated mortality to target and non-target species. These approaches can also be used to identify the optimal formulation and application procedures for chemistry based pest control scenarios.

Purpose:

Pesticides are often developed to reduce agricultural losses due to pest species. These pesticides provide many benefits to producers and consumers. However, pesticides may also pose hazards to non-target wildlife species [1-6]. To assure that society can continue to reap the benefits of pesticide use, the magnitude of risks to non-target wildlife need to be identified [1-3]. When such non-target risks are significant, it behooves applicators to adopt procedures that minimize undesirable risks to non-target species while maintaining efficacy towards pest species.

Rodents cause significant losses to agricultural commodities. Additionally, rodents are vectors for diseases which impact humans. Anticoagulant pesticides are effective pesticides for reducing pest rodent populations and associated damage. Unfortunately, non-target wildlife can be negatively impacted by these pesticides via primary exposure (exposure due to consumption of pesticide baits) or secondary exposure (exposure to pesticide due to consumption of poisoned target pest species) [3-5].



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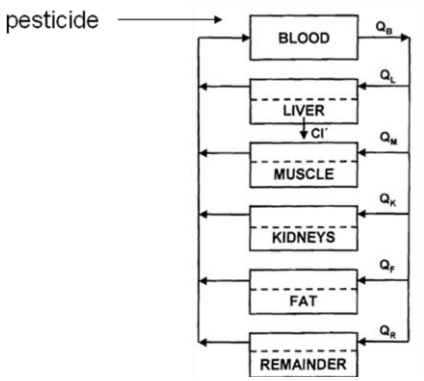
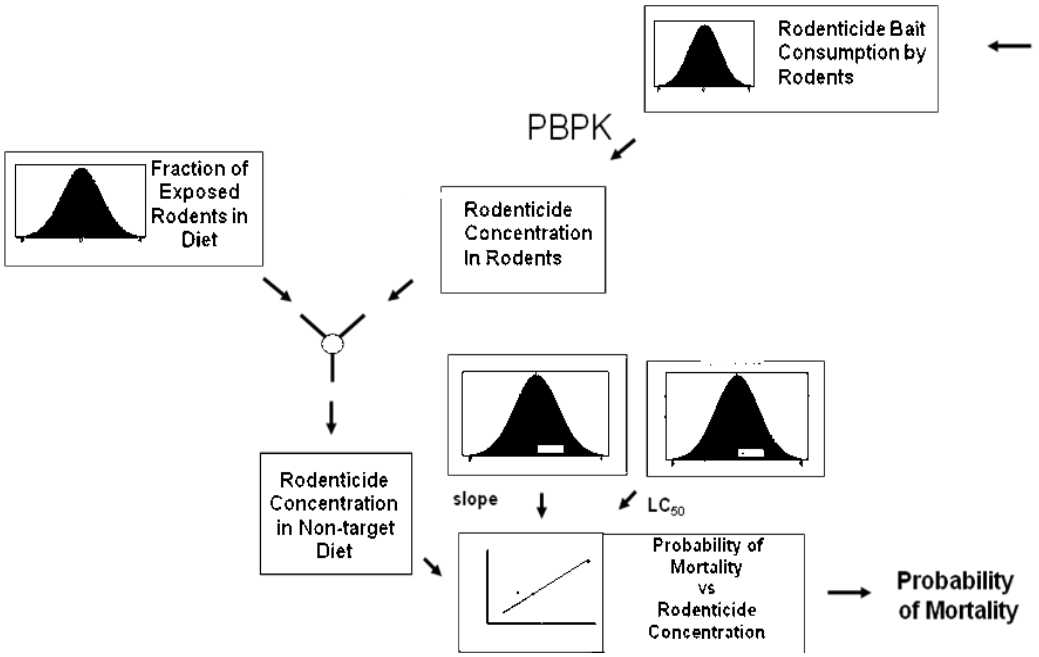
X consumption. Pesticide concentration in the formulated bait is fairly consistent. However the concentration of pesticide in the target species can be quite variable due to variability in application

procedures, environmental conditions, the quantity of bait consumed, etc. To estimate the concentration of pesticide in the target species, a Physiologically Based Pharmacokinetic Model was developed and subsequently validated by comparing the model estimates to rat pesticide concentrations following various pesticide exposure scenarios [3].



These PBPK model estimated rodent pesticide concentrations were incorporated into a probabilistic toxicity model to estimate the impact of secondary pesticide exposure on non-target wildlife.



anticoagulant pesticide formulation to target pest rodent species as well as to non-target wildlife. Comparison of the relative estimated mortalities confirms that anticoagulant pesticides are effective for reducing pest rodent populations but may have negative impacts on non-target species. However, application of these modeling approaches can be used to identify formulation and application scenarios which optimize efficacy and minimize undesirable effects to non-target wildlife.

References:

[1] Johnston, J.J., Stahl, R.S., Homan, H.J., Linz, G.M., Pitt, W.C. 2008. Probabilistic Bioenergetic/Toxicity Modeling Approach for Estimating Toxicant Induced Mortality to Target Invasive Species and Non-Target Wildlife. Proc. Managing Invasive Species. August 7 – 9, 2007. Fort Collins, CO 393- 397.

[2] Johnston, J.J. 2008. PBPK and Probabilistic Models for Estimating Pesticide Associated Target and Non-target Hazards. Pesticides in Urban Environments. Society for Environmental Toxicology and Chemistry North American Meeting, Tampa, FL, USA.

[3] Johnston, J.J. and Andersen, M. 2007. Estimating non-target exposure to anticoagulant rodenticides with a PBPK model. Society for Environmental Toxicology and Chemistry Europe. Porto, Portugal.

[4] Johnston, J.J, Primus, T.M., Kohler, D.J.,Holmes, M.J., Hart, A.. 2005. Probabilistic model for estimating field mortality of target and non-target bird populations when simultaneously exposed to avicide bait. Pest Management Sci. 61:649-659.

[5] Johnston, J.J., Pitt, W.C., Sugihara, R.T., Eisemann, J.D., Primus, T.M., Crocker, J., Holmes, M.J., Hart, A. 2005. Probabilistic risk assessment for snails, slugs and endangered honeycreepers in diphacinone baited areas on Hawaii, USA. J. Env. Toxicol. Chem. 24: 1557-1567.

[6] Johnston, J.J., Savarie, P.J., Primus, T.M., Eisemann, J.D., Hurley, J.C. 2002. Risk assessment of an acetaminophen baiting program for chemical control of brown treesnakes on Guam – evaluation of baits, snake residues and potential primary and secondary hazards. Environmental Science & Technology 36: 3827-3833.