REP 1995-075

1995. Pages 411-422 *in* C.H. Racine and D. Cate, eds., Interagency Expanded Site Investigation: Evaluation of White Phosphorus Contamination and Potential Treatability at Eagle River Flats, Alaska - **FY94 Final Report**. 2 Vols. Prepared by U.S. Army Cold Regions Research and Engineering Laboratory for U.S. Army, Alaska Directorate of Public Works. 698 pp.

VI. Treatability Studies

VI-1. CHEMICAL HAZING OF FREE-RANGING DUCKS IN EAGLE RIVER FLATS: FIELD EVALUATION OF ReJeX-iT™ WL-05

Lawrence Clark and John Cummings

Denver Wildlife Research Center, USDA

INTRODUCTION

An encapsulated product containing the bird repellent, methyl anthranilate, was developed for the purposes of chemically hazing waterfowl from contaminated marshland. The method and rationale behind chemical hazing is as follows. Repellent material is encapsulated within a gel-alginate capsule designed to break under the bill pressure of ducks (Clark and Cummings 1994). Capsules are spread onto the sediment of contaminated wetlands, and filter-feeding waterfowl encountering the capsules cause a release of the repellent material into their oral cavity. Previous laboratory and pen studies indicated that feeding rate decreased in areas treated with repellent capsules (Clark and Cummings 1994). This is important because it is presumed that risk of encountering a white phosphorus particle is related to the intensity of feeding activity. However, based upon other studies where repellent material was applied to a resource, we found that birds may be induced to substantially avoid treated areas, hence further reducing the

ACKNOWLEDGMENTS
We thank the U.S. Army Environmental Center for providing financial support for this project, and William Gossweiler and the staff of Public Works at Fort Richardson for providing logistical support. We followed criteria outlined by the Animal Welfare Act and the DWRC Animal Care and Use Committee.

presumptive risk of encountering lethal WP particles (Cummings et al. 1991, Mason and Clark 1995). The object of this study was to determine if treatment of sediment would cause free-ranging waterfowl to avoid treated areas.

METHODS

Methyl anthranilate assays

The encapsulated methyl anthranilate was codeveloped by the DWRC and PMC Specialties Group, Inc. of Cincinnati, OH and is trademarked under the name ReJeX-iT™ WL-05. Repellent capsules, containing 14% methyl anthranilate by weight, are composed entirely of food-grade materials designed to degrade after a short exposure to natural environmental conditions. Inert carriers and encapsulating material are proprietary information of PMC Specialties Group, Inc.

Product stability under laboratory and natural environmental conditions was evaluated. In the laboratory, beads (WL05 lot # ES940715A) totalling a known weight were loosely packed in a column and water was passed through the column. Aliquots of water were sampled at timed intervals ($n = 79$) and methyl anthranilate content was measured using standard HPLC procedures (Clark et al. 1993). Fast (initial pulsatile) and slow (equilibrium) release of methyl anthranilate was estimated in this continuous flow system and estimates of total releasable, total unreleasable and half-life of methyl anthranilate within the bead was estimated numerically.

In the field, thirty samples of WL-05, lot # ES940715A, were weighed (15 g/sample), sealed in nylon screen pockets, and placed on the surface of the sediment, under water, in Area C. Placement of samples in Area C was random. Three samples were removed at 24-hr intervals for each of ten days post-placement. Samples were scrapped into acid-washed amber vials containing 40 ml of 0.1 ppm sodium azide solution. Sodium azide is a metabolic poison that kills all aerobic life. Aerobic bacteria were previously implicated as being important methyl anthranilate degradation agents (Clark et al. 1993). There is no indication that anaerobic bacteria substantially affect the longevity of methyl anthranilate (L. Clark, personal observation). Samples were labeled, sealed and sent to the Monell Chemical Senses Center for analysis. An index of methyl anthranilate content of beads was calculated, but should not be interpreted as the total amount of methyl anthranilate in a bead. Rather, the index is a measure of the overall failure rate of the bead. The index was calculated as follows. The equilibrium methyl anthranilate content of the aqueous phase of the sample on day *t* was normalized to the weight of the field recovered sample and divided by the weight-normalized aqueous phase methyl anthranilate content of beads from time zero.

Field application rates

Although methyl anthranilate and several ReJeX-iT™ formulations are registered for specific uses by the U.S. Environmental Protection Agency, the WL-05 formulation is not registered for commercial use. Therefore, field evaluations were kept below the 0.4 ha threshold for wetlands exempting authorization requiring an experimental use permit. Four areas consisting of approximately 930 m^2 each were treated.

C-Pond

The C-pond was divided into five areas (Fig. VI-1-1) and the number of ducks within each area was counted every 15 min for a 2-hr period according to a randomly determined time stratified design. Although counts were made by species, for the purposes of this analysis counts consist of total number of mallards (*Anas platyrhyncos*), northern pintails (*Anas acuta*), and green-winged teal (*Anas crecca*) (those species historically at greatest risk to WP poisoning). Counts were made from the C-tower/blind. Normally, the observer would enter the tower one hour prior to initiating the observations. This time period seemed to allow ducks to return to the area if disturbed. The daylight hours were divided into three time periods: morning, 0600-1000; midday, 1000-1600; evening, 1600-2200 h. Ducks were reliably absent in any numbers at observation points during the midday sampling period, therefore formal observations during this period were discontinued.

Area "C-L" at the southern end of the C-pond was treated on 12 August 1994. Area "C-L" measured approximately 15 × 46 m for a total of 690 m^2. A total of 61 kg of WL-05 was broadcast spread by hand over this area, yielding a total of 0.108 kg methyl anthranilate per square meter, or 0.792 kg of WL-05 per square meter.

The treatment appeared to be only marginally effective. It was decided that an expansion of the treatment area was warranted rather than a change in application rate. Area "C1" north but adjacent to Area "C-L" was treated on 17 August

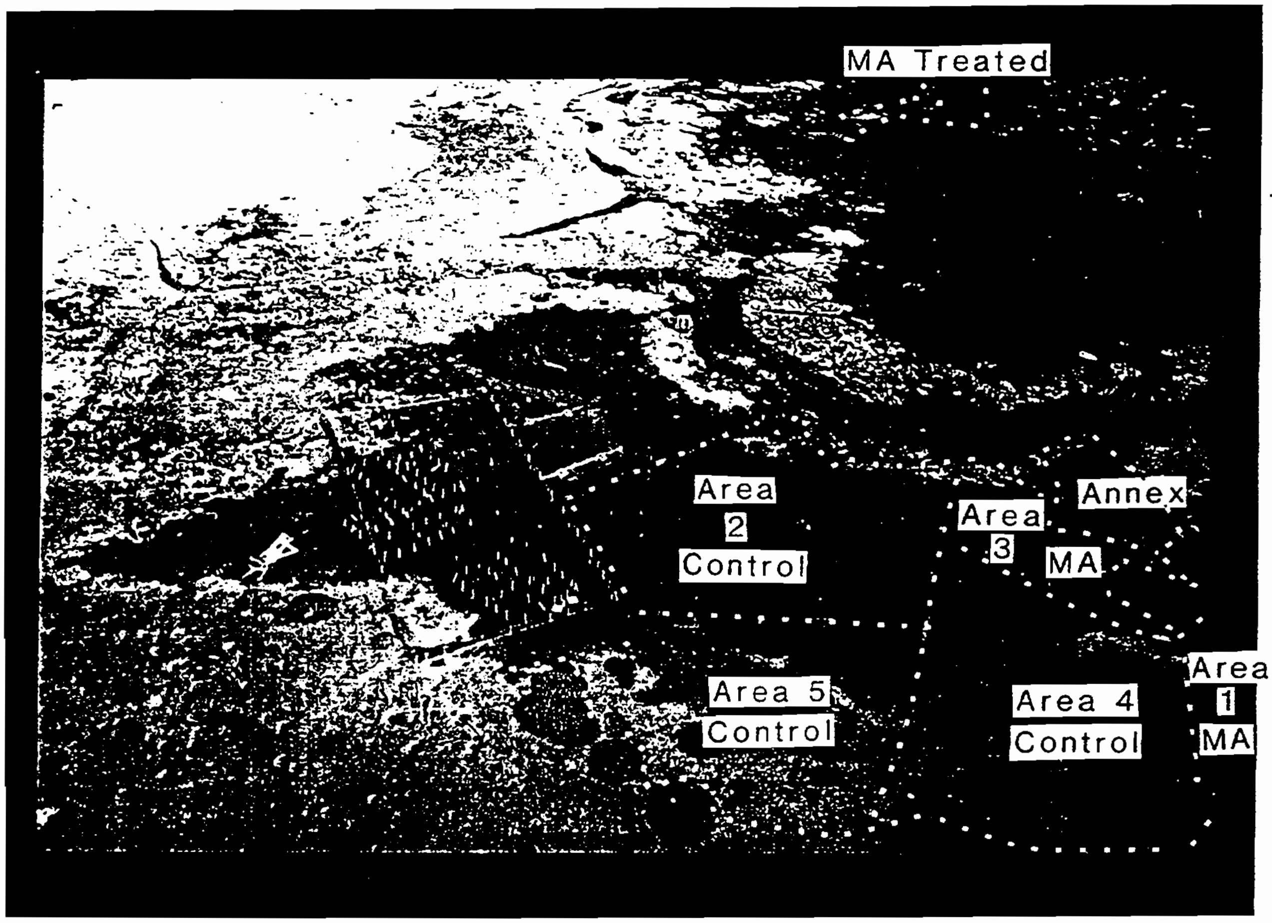

Figure VI-1-1. Area C and the C/D transition, indicating the boundaries of the treated and untreated observations sites.

1994. Area "C1" measured approximately 30 × 30 m for a total of 900 m^2. Area "C3" north but adjacent to Area "C1" was also treated on 17 August 1994. Area "C3" measured 30 × 30 m for a total of 900 m^2. For each of these plots a total of 109 kg of WL-05 was broadcast spread by hand over this area, yielding a total of 0.017 kg methyl anthranilate per square meter, or 0.121 kg of WL-05 per square meter.

All other plots within the C-pond served as untreated controls.

C-D Transition

Two ponds in the C-D Transition were observed from the turnout overlooking the beaver channel (Fig. VI-1-1). Initially ducks appeared to be using only one of the ponds. This pond was selected for treatment. An area of approximately 30 × 30 m was marked and an application of 0.017 kg methyl anthranilate per meter was applied on 17 August 1994. The pond was slightly larger than the treatment

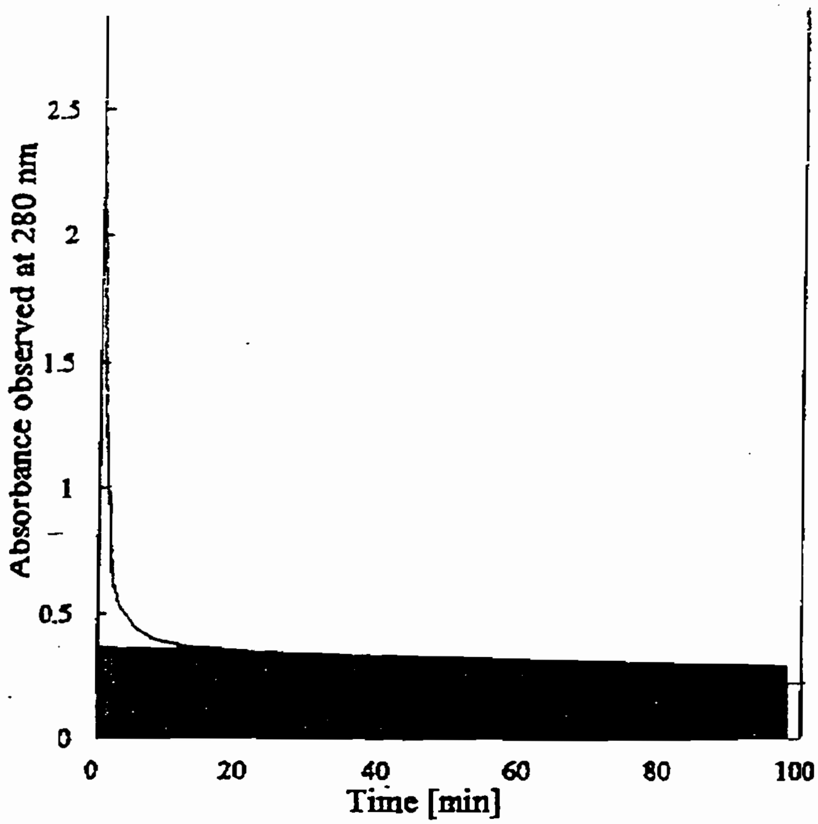

Figure VI-1-2. Release rate of methyl anthranilate as a function of time in a standardized water column. The half life of WL05 ES940715A was 295.04 min.

plot size, but no attempt to treat the entire pond was made. Counts and sampling periods were determined as described above.

RESULTS

Based upon information provided by the manufacturer and laboratory assays, one hundred percent of the methyl anthranilate contained in WL05 beads was released to water. A total of 2.5% of the methyl anthranilate content of the bead was lost at initial wash out, thereafter, the remaining 97.5% was lost at a constant rate (constant = -1.00 ± 0.004 SE, coefficient = -0.002 ± 0.00002 SE, Fig. VI-1-2). The estimated half life of this formulation was 295 min under the test conditions.

At the onset of observations at the C-pond ducks seemed to prefer the southern end, closest to the C-tower. Treatment of area "C-L" did not have an effect on use of that area in general. Closer inspection of the data suggested that use was restricted to a small pool and other treated areas were largely abandoned, how-

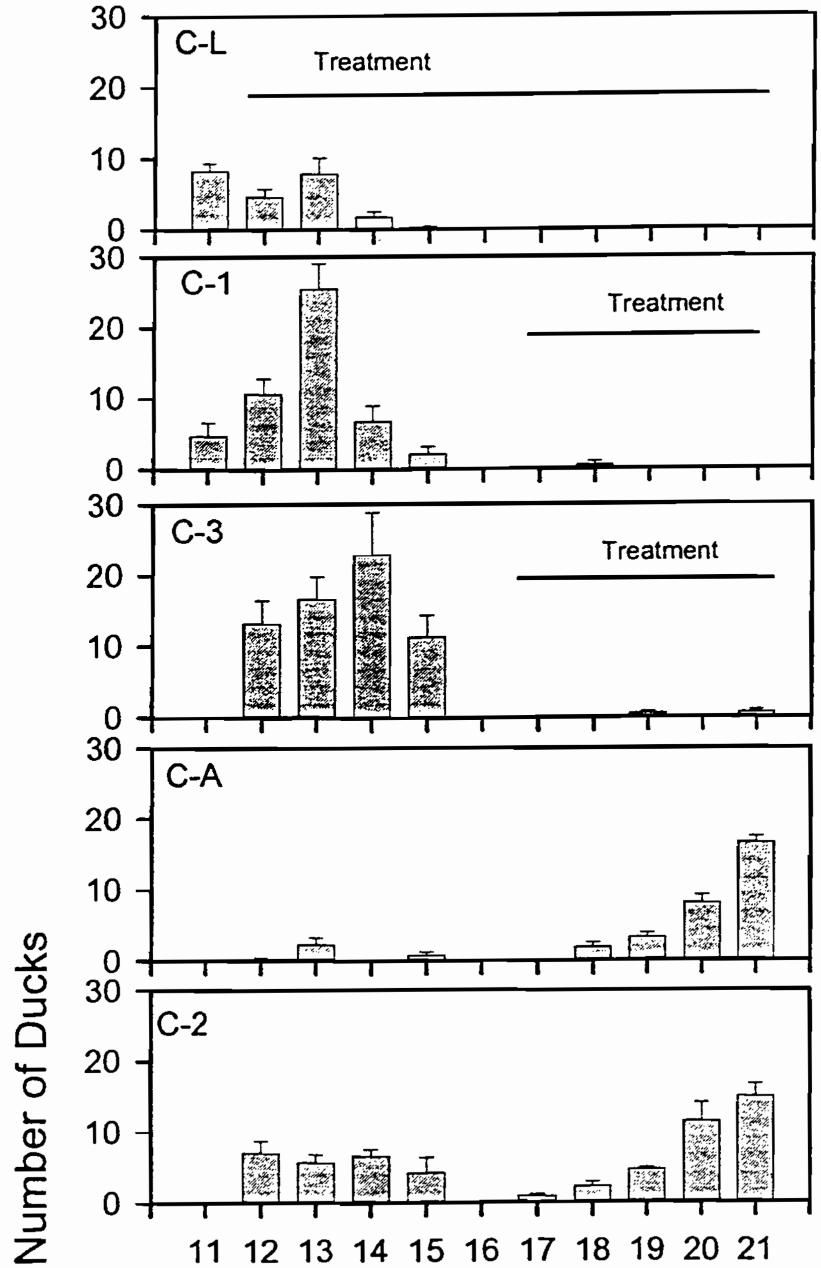

Figure VI-1-3. Number of ducks (mallard, pintail, teal) observed every 15 min as a function of days in different areas of the C-pond. The arrows depict treatment with WL05 beads.

ever, there was an increase in use of untreated adjacent areas. When areas "C1" and "C3" were treated use of these areas stopped and use of adjacent untreated areas increased (Fig. VI-1-3). These overall patterns are not compelling examples of repellency by themselves, though there was a trend to "push" the ducks north as treatment progressed. This pattern is more visible when the number of sight-

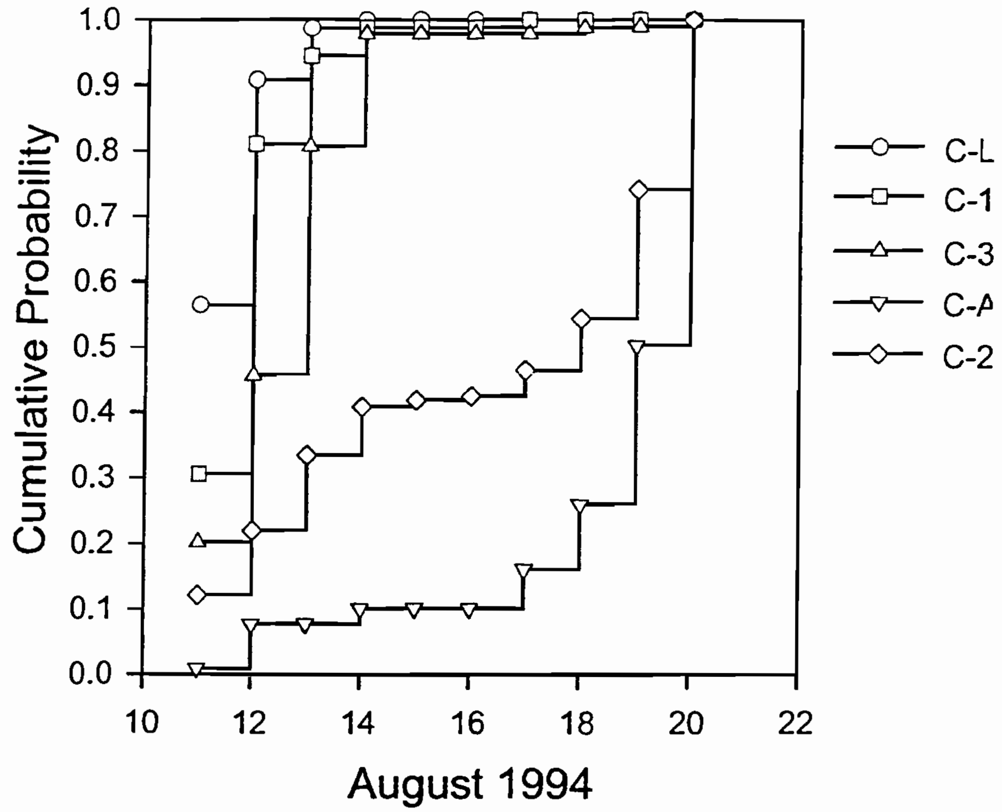

Figure VI-1-4. Cumulative proportion of ducks observed for each of the sites in C-pond as a function of days. Lag time is a good measure of the success of the bead treatment strategy. Lag is the number of days it takes to get to P = 1.0 after treatment. For treated areas 1 and 3 the lag time was 1 day, for the untreated controls the lag time was 6 days.

ings is plotted as a cumulative probability curve (Fig. VI-1-4). More compelling, however, was the fact that the displacement was also observed at the C-D Transition ponds under observation and the dramatic changes in normal feeding behavior of ducks encountering a treated area (Fig. VI-1-5).

Detailed observations of ducks entering a treated area indicate that the repellent did have an effect on behavior, a summary of the records is as follows: Ducks in untreated areas spent 70–90% of their time feeding, typically moving back-and-forth through an area. In contrast, ducks entering the treated areas would stop feeding within 2 m of entering the area, then proceed in a linear manner to the opposite side's boundary. Once reaching the boundary markers, the ducks would initiate feeding activity once more. This pattern was observed a total of 19 times for 50 ducks over the course of three days. These numbers are not reflected in the timed samples because the residence time in the treated areas was usually brief.

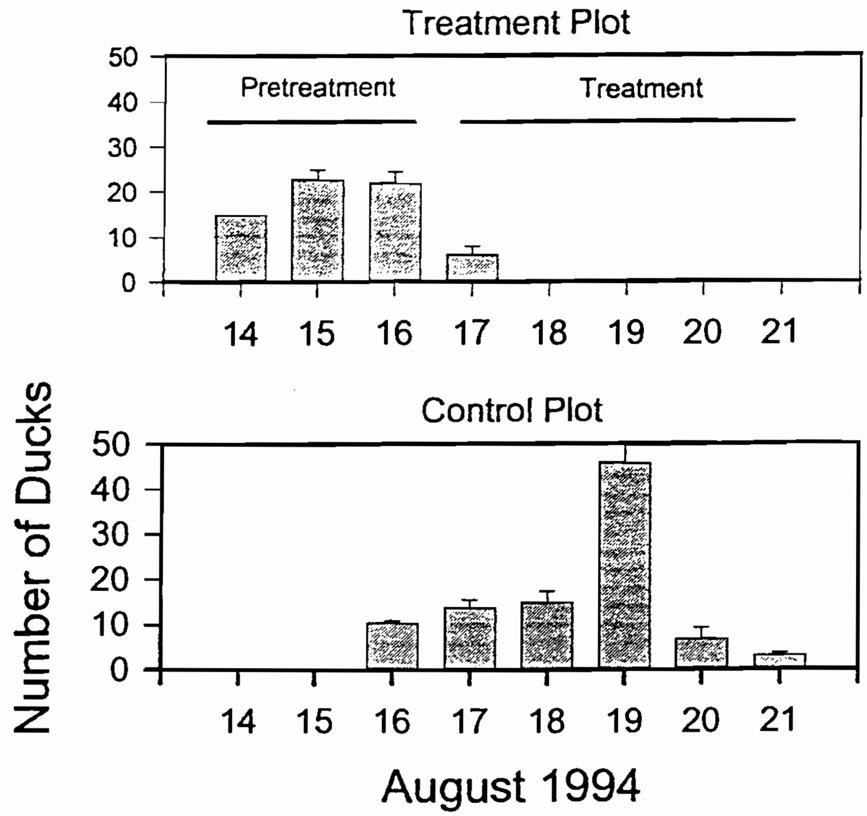

Figure VI-1-5. Number of ducks (mallard, pintail, teal) observed every 15 min as a function of days in different areas of the C-D transition. The arrows depict treatment with WL05 beads.

DISCUSSION

The water column data on methyl anthranilate release show that loss of the repellent material is constant over time. However, in the field the data suggest high level of integrity between 0 and 5 days where upon there is catastrophic failure of the bead, resulting in significant loss of methyl anthranilate (Fig. VI-1-6). Physical inspection of beads over time indicate that on days 0-5 the bead is firm, where as older beads take on a mushy texture. Given the organic nature of the shell (gel alginate) we suggest that the integrity of the bead is attacked by microbes as a nutrient source (Karsa and Stephenson 1993). This attack may render the membrane sufficiently permeable so as to increase the rate at which methyl anthranilate is lost from the capsule. The field failure rate for all PMC capsules tested to date is about five days and cannot generally be improved upon so long as a biodegradable gel alginate capsule is used.

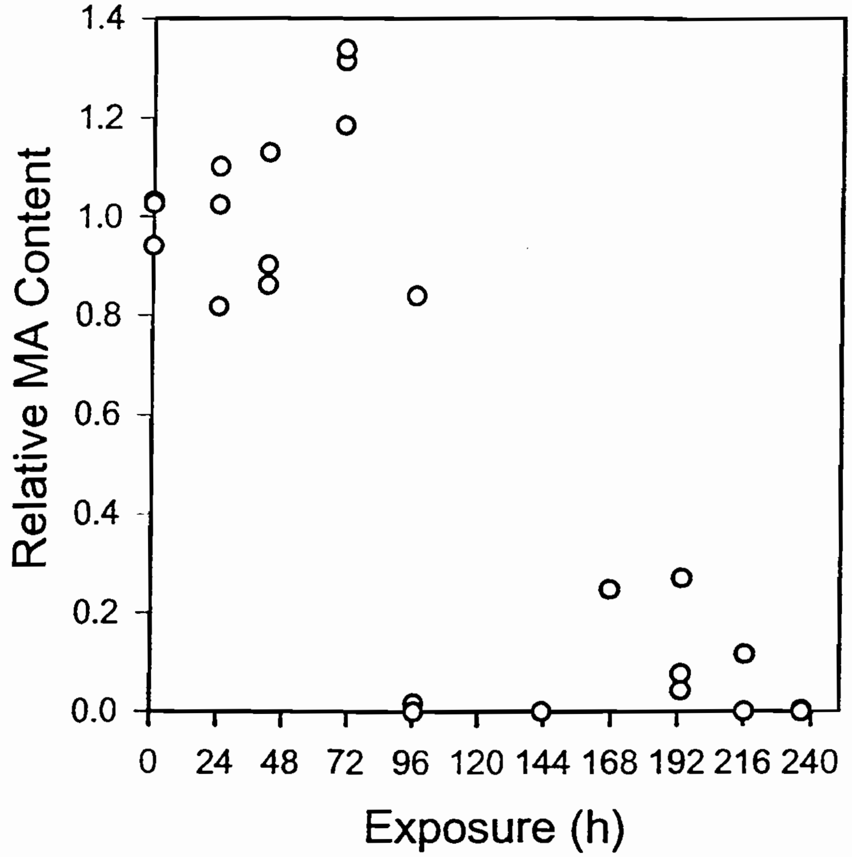

Figure VI-1-6. Potential life expectency of repellent capsules in the field as estimated by the index for methyl anthranilate content of beads. Individual capsules weigh 14.5 μg and contain 2.03 μg methyl anthranilate. The index represents the capacity to saturate an aqueous solution (40 mL) of the aggregate number of beads in a sample.

Water levels in the Eagle River Flats was low and decreased during August 1994. As a result, waterfowl activity was concentrated into a few ponds. These conditions were ideal for the proposed treatment. Sufficient material was applied to provide adequate coverage of the sediment. The detailed behavioral data suggest that ducks readily recognized boundaries of treated areas, and entered such areas only as a means of transit from one untreated site to another. There may be a minimum area effect for an effective treatment. A treatment of less than 0.1 ha did not appear to repel ducks from that area. As the cumulative total area of a treatment increased, the number of entries into the area decreased. These data are suggestive of an overall area repellent effect, but by themselves are not conclusive of the effect.

The data should be viewed as a series of case studies consistent with the anticipated repellent effect of WL-05. Moreover, the results are consistent with observations of waterfowl behavior in terrestrial situations (Mason and Clark 1995). We conclude that treatment of the sediment with encapsulated repellent may be a viable strategy to prevent ducks from using WP contaminated areas.

RECOMMENDATIONS

Using methyl anthranilate does have some utility as a chemical hazing tool based upon these case studies and those carried out on turf and at landfills (Mason and Clark 1995, Vogt 1994). If used as a hazing tool on Eagle River Flats, WL-05 should be employed over contaminated areas greater than 900 m^2 at an application rate of 0.017 kg active ingredient/square meter. Although WL-05 was designed for use in wetlands, it is not EPA registered for that use. Discussions of intents regarding registration for this specific application need to be carried out by the Army and the manufacturer. During the interim, larger areas of Eagle River Flats may be treated under an experimental use permit from the EPA to the Army. As a condition for this approach, efficacy will need to be assessed. Thus, waterfowl use of treated vs untreated areas will need to be monitored. The price structure for WL-05 has not been set and should be negotiated between the Army and the manufacturer.

SUMMARY

Water levels in the Eagle River Flats were low and decreased during August 1994. As a result, waterfowl activity was concentrated into a few ponds. These conditions were ideal for the proposed treatment. Sufficient methyl anthranilate beads were applied to provide adequate coverage of the sediment. The detailed behavioral data suggest that ducks readily recognized boundaries of treated areas, and entered such areas only as a means of transit from one untreated site to another. There may be a minimum area effect for an effective treatment. A treatment of less than 0.1 ha did not appear to repel ducks from that area. As the cumulative total area of a treatment increased, the number of entries into the area decreased. These data are suggestive of an overall area repellent effect. We con-

clude that treatment of the sediment with encapsulated repellent may be a viable strategy to prevent ducks from using white phosphorus contaminated areas. If used as a hazing tool on Eagle River Flats, methyl anthranilate beads should be employed over contaminated areas greater than 900 m^2 at an application rate of 0.017 kg active ingredient per square meter.

The water column data on methyl anthranilate release shows that loss of the repellent material is constant over time. However, in the field the data suggest a high level of integrity between 0 and 5 days whereupon there is catastrophic failure of the bead, resulting in significant loss of methyl anthranilate. Physical inspection of beads over time indicate that on days 0–5 the bead is firm, whereas older beads take on a mushy texture. Given the organic nature of the shell (gel alginate) we suggest that the integrity of the bead is attacked by microbes as a nutrient source. This attack may render the membrane sufficiently permeable so as to increase the rate at which methyl anthranilate is lost from the capsule. The field failure rate for all beads tested to date is about five days and cannot generally be improved upon so long as a biodegradable gel alginate capsule is used.

REFERENCES

Clark, L., J. Cummings, S. Bird and E. Aronov (1993) Acute toxicity of the bird repellent, methyl anthranilate, to fry of *Salmo salar, Oncorhynus mykiss, Ictalurus punctatus* and *lepomis macrochirus*. *Pestic. Sci.*, **39:** 313–317.

Clark, L. and J.L. Cummings (1994) Field behavioral response and bead formulations for methyl anthranilate encapsulated bird repellents. Pages 281-294 *in* Racine, C.H. and Cate, D. (eds.) Interagency expanded site investigation: evaluation of white phosphorus contamination and potential treatability at Eagle River Flats, Alaska. U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH.

Cummings, J.L., J.R. Mason, D.L. Otis and J.L. Heisterberg (1991) Evaluation of dimethyl and methyl anthranilate as a Canada goose repellent on grass. *Wildl. Soc. Bull.*, **19:** 184–190.

Karsa, D.R. and R.A. Stephenson (1993) Encapsulation and controlled release. Royal Chemical Society, Cambridge.

Mason, J.R. and L. Clark (1995) Evaluation of methyl anthranilate and activated charcoal as snow goose grazing deterrents. *Crop Protec.* (in press).

Vogt, P.F. (1994) ReJeX-iT AG-36 as bird aversion agent for turf and agriculture. Proc. Vertebr. Pest Conf., **16:** 275–278.