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Foraging Thresholds of Spring Migrating Dabbling Ducks in Central Illinois

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Summary

As of mid-November 2010, we have: 1) completed 1 season of field work related to this project, including conducting 7 foraging trials in 3 different wetlands; 2) processed 185 foraging-trial samples, and; 3) compiled preliminary results. Spring migration was compressed in 2010 due to a late thaw, which may have led to faster turnover (i.e., shorter duration of stay) of ducks at our study sites, thereby influencing their willingness to forage in trial plots. Duck use of trial plots was greater early in migration than late, corresponding in decreased seed consumption (i.e., increased giving-up density [GUD]) over the course of spring. Herein, we report our activities, preliminary results, and potential modifications to the experimental design for the 2011 field season.

1) Experimentally estimate GUD (kg/ha) of migratory mallards and other dabbling ducks during Spring (e.g., late-February to mid-April) in moist-soil wetlands in central Illinois.

We conducted 7 experimental trials at 3 wetland complexes in central Illinois during spring 2010. Our study sites included wetlands that were readily used by mallards (*Anas platyrhynchos*) and other dabbling ducks (*Anas* spp.), were accessible by all-terrain vehicle (i.e., to place and remove experimental foraging patches), and could be observed from a distance without disturbing the study plots. Thus, we conducted 3 trials at Spring Lake Bottoms State Fish and Wildlife Area (Illinois Department of Natural Resources) in Tazewell County, 3 trials at Sand Lake (privately owned) in Mason County, and 1 trial at The Emiquon Preserve (The Nature Conservancy) in Fulton County. We initiated trials 17 March (i.e., immediately after ice receded) and concluded 12 April, after most dabbling ducks had departed. Ice-out was considerably later than normal in 2010, which lead to a compressed spring migration period and a relatively short amount of time to conduct the experiments. Individual trials lasted 6–21 days, depending on the amount of duck use that trial plots received or if they were clearly abandoned.

2) Evaluate if GUD of spring-migrating dabbling ducks in central Illinois varies with respect to initial seed density (kg/ha), seed size (e.g., large or small), predation risk (e.g., visual obstruction near foraging sites), substrate type (e.g., sand or clay), or environmental covariates (e.g., temperature).

Trial Design and Methods

We deployed 33 plastic pans (36.8 cm diameter by 8.9 cm depth) filled with 1 of 11 different treatments (Table 1) for each trial that manipulated 5 factors.

Seed Density–Abundance of seed resources clearly influences habitat quality and selection by dabbling ducks. We hypothesized that rich sites would be occupied longer and foraged more extensively than poor sites. We investigated patch depletion by dabbling ducks by deploying seed trays with various seed densities, representing low (350 kg/ha), average (580 kg/ha), and high (1,120 kg/ha) estimates used for conservation planning by Soulliere et al. (2007:34).

Seed Size–It is poorly understood if dabbling ducks actively select moist-soil plant seeds of specific sizes. However, large seeds likely represent higher-quality rewards and/or may be more readily encountered over small seeds and may thus be preferentially consumed. To examine the influence of seed size on patch depletion, we deployed trays with large (red rice; *Oryza sativa* var.) or small (Japanese millet; *Echinochloa crus-galli*) seeds only, as well as trays with equal masses of each seed size.

Substrate Depth–It is unclear how efficient dabbing ducks are at consuming seeds below the substrate surface. To investigate the influence of seed depth on foraging thresholds, we deployed trays with known amounts of seed that were: 1) mixed homogenously through 7.6 cm of substrate; 2) mixed throughout the upper 3.8 cm only (0–3.8 cm depth), and; 3) spread throughout only the lower 3.8 cm (3.8–7.6 cm depth). We expected that deeply-buried seeds would require more effort to forage successfully than shallow seeds; thus GUDs should be greatest (i.e., depletion least) for the deep treatment, least for the shallow treatment, and intermediate for the mixed treatment.

Substrate Type–The relationship between substrate firmness and foraging success by dabbling ducks is largely unknown. Thus, we used 3 substrate types (firmnesses) to evaluate GUD in relation to difficulty of accessing seed. We classified substrates as: 1) clay; a dense mixture of bentonite clay and water; 2) clay-sand; 60% silica sand and 40% bentonite clay mixed until homogenous when dry and then mixed with a pre-determined amount of water to create a moderately-dense substrate, and; 3) sand; composed entirely of silica sand. These 3 substrates were intended to reflect a range of benthic conditions encountered by foraging ducks from relatively easy to relatively difficult. We predicted that seeds buried in sand would require the least effort to consume (i.e., least GUD), followed by seeds in the mixed, and then clay substrates (i.e., greatest GUD).

Predation Risk–We created 4 seed and substrate combinations for visual obstruction trials (Table 1). Each combination was replicated 3 times and a replicate was placed in each of 3 groups of pans located 1 m, 5 m, and 10 m from a 2.4 m by 1.5 m commercially available woven grass mat suspended vertically just above the water on metal conduit poles driven into the substrate.

In addition to the 11 treatment combinations (Table 1), we included a “control” pan during each trial, which was enclosed in wire mesh to prevent seed predation or loss, to estimate potential seed loss to decomposition during trials.

To make each experimental foraging patch (pan), we mixed the treatment-specific amount of seed with the treatment-specific amount and type of substrate(s) and a pre-determined amount of water until the mixture was the desired consistency. We covered the surface of the substrate in each experimental pan with wet straw to mimic natural plant debris found in moist-soil wetlands. Unfortunately, the process of compiling and mixing experimental pans was time and labor intensive, requiring ~32 person-hours to produce the 34 experimental foraging patches required for one trial. Further, we did not mix experimental pans >1 day prior to deployment to minimize chances of seed degradation or germination. To improve efficiency and minimize redundancy, we reduced the number of experimental patches (pans) in the 4th and 5th trials to 31 and 28, respectively.

In the field, we placed pans in a grid pattern in shallow water (15–35 cm) near duck concentrations within wetlands, and randomized patch distributions within plots using a random-numbers table. We monitored plots daily for duck use or abandonment by conducting 1 hr of behavioral observation in the morning or evening. Additionally, we used the time-lapse function on motion sensitive "trail-cameras" to take a picture of experimental plots hourly to aid in documenting use or abandonment.

We removed experimental foraging patches from wetlands when observations and/or photos indicated that ducks were no longer feeding in trial plots. Following plot removal, we transported pans to the laboratory and rinsed contents through a #14 (1.4 mm) sieve that retained seeds but allowed the passage of substrate. We dried seeds to constant mass and weighed them (± 1 mg).

We applied 2 corrections to post-experiment dry mass values. First, seeds were not dried and weighed prior to deploying treatments. To account for moisture in seeds at deployment we dried 1 g and 5 g samples of red rice and millet at 80° C to a constant mass. We used the percent of mass lost during drying as a correction factor for post-experiment dry mass values. Thus, we increased the dry mass of recovered millet seeds by 11.2% and recovered rice seeds by 9.9%. Second, recovery of seeds from control pans indicated that (dry weight corrected) masses of red rice were essentially unchanged since deployment, whereas millet masses were lower than expected unless decomposition occurred. Because each set of treatment and control pans were deployed on different dates and for different lengths of time, we estimated the rate of mass loss of millet seeds in control pans for each deployment date. Then, we corrected for decomposition by using the number of days treatments were exposed and the estimated decomposition rate (i.e., from control pans). We used only these corrected values in evaluating the proportion of food consumed and the amount left when abandoned (GUD). Finally, corrected mass values indicated that ducks did not forage in all experimental patches. Thus, unless noted otherwise, preliminary results only include data from pans where corrected seed-mass values were less than the amount when deployed.

Preliminary Results

Seed Density–We duplicated a range of natural seed densities observed in our area in trial pans. We postulated that higher initial seed densities would associate with greater consumption and, hence, lower GUD. Although the degree to which experimental patches were depleted varied considerably, the overall pattern of results generally supported our hypothesis in a stepwise fashion; that is, more seed was consumed from high than medium density patches, and more from medium than low density patches (Figure 1). Thus, it appears that ducks were able to evaluate foraging-patch quality. Interestingly, seed was consumed from patches of all densities, but high density patches were not depleted to the level of medium density patch. Likewise, medium density patches were not depleted to the level of low density patches. Thus, consumption by dabbling ducks did not appear to follow an ideal-free distribution, and we cannot be certain if GUD was actually reached or if duck use was insufficient to reach GUD.

Seed Size–We hypothesized that GUD would be lower in patches with large seeds than small seeds. Contrary to our expectations, dabbling ducks generally consumed more small than large seed in 2010 (Figure 1). We cannot account for this apparent preference, but it appeared to be further related to seed density, as the high-density small-seed treatment experienced the most consumption. However, more small seed was also consumed from medium and low density patches than those with large seed, perhaps indicating that GUD may be lower for small seeds overall.

Substrate Type–We predicted that GUD would be least in sand substrate and would increase with increasing amounts of clay. The pattern of consumption we observed was generally consistent with this hypothesis, although results were not consistent. Ducks appeared to forage more successfully in the sand-substrate patches, but GUDs in patches with mixed and clay substrates were more similar (Figure 2).

Substrate Depth–We predicted that GUD would be higher for deeply-buried seeds than for seeds close to the surface. Ducks consumed about 30% of food in patches where seeds were only in the upper portion of the pans (shallow depth; 0–3.8 cm). However, we did not detect any consumption of in patches where all seeds were deeply buried (3.8–7.6 cm; Figure 3).

Therefore, our hypothesis was generally supported, and GUD is likely much lower for seeds attained near the substrate surface. We note that all patches created to evaluate the influence of seed depth on foraging thresholds used clay-sand substrate. Although our results should be replicated, this finding could have important implications for conservation planning (e.g., if seeds below a certain depth are not consumed, but are considered available during sampling).

Predation Risk–We hypothesized that GUD would decrease as foraging patches were placed further from the visual obstruction (i.e., greater risk of predation), that GUD would be lower in patches with sand than clay-sand substrate, and that GUD would be lower in patches with large seeds. We were only able to conduct 2 visual-obstruction trials and results were somewhat inconclusive. No trend emerged between GUD and the distance from the visual barrier, although ducks consumed slightly more seed at the 5 m distance than at 1 m or 10 m (Figure 4). As with other trials, ducks consumed more seed from patches with sand than clay-sand substrate (Figure 4), but this may have been independent of the visual obstruction. Ducks also consumed more millet than rice (Figure 4), which was consistent with other trials. We will conduct more visual obstruction trials in 2011 to elucidate the relationship between GUD and a visual obstruction representing increased predation risk or, potentially, safe-cover from predators. We will likely simplify future trials to include only one substrate type and seed size to remove confounding influences that will already be evaluated separately.

Waterfowl Behavior–We conducted 284 behavioral observations using scan sampling (Altmann 1974) of all dabbling and wood ducks (*Aix sponsa*) within 100 m of study plots. We typically conducted 5 consecutive scans over the course of 1 hr and used the following 6 behavioral categories: feeding, resting, other (e.g., comfort and preening), social, locomotion, and alert. We recorded behavior by sex and estimated the overall species composition of ducks included in each scan.

Dabbling ducks spent most (52.7–59.4%) of their time foraging near trial plots (Table 2), which was consistent with results from other behavioral studies conducted during spring (Paulus 1984, Paulus 1988). Interestingly, behavior did not differ between trials 1–5 and the 2 visual obstruction trials (Table 2). We anticipated that ducks may have spent less time foraging and more time alert near the visual obstructions, but this was not the case; in fact, time spent alert was slightly lower at visual-obstruction trial plots (Table 2). Overall, ducks did not appear to adjust their behavior to avoid barriers (e.g., more time alert) or exploit high density plots (e.g., hyperphagia, agonistic interactions competing for plots) as a result of our trials, which was not surprising given the difficulty we encountered attracting ducks to the study plots.

Future Work–Despite a successful pilot study in 2009, we encountered difficulty getting ducks to forage in our experimental plots in 2010. It is possible that ducks readily foraged in test plots during our pilot study because we used a different substrate (natural sand) and different foods (corn and white proso millet). We intend to evaluate potential aversion to seeds or substrates we used in 2010 through trials with captive ducks. If captive ducks avoid a food or substrate, we will attempt to identify more attractive options. Additionally, in 2011, we will attempt to pre-bait sites prior to conducting trials to habituate ducks to feeding in pans, a common practice in other GUD studies. We also suspect that an earlier (e.g., more normal) ice recession in 2011 may result in longer residency times and improved success in attracting ducks to our experimental plots. Such conditions will allow greater flexibility in number of trials conducted, trial length, and overall quality. Finally, we believe we implemented too many treatment combinations to effectively deploy and evaluate in a short time period. Thus, we intend to revise the experimental protocol to reduce the number of treatments and focus on factors that are most realistic and relevant to conservation. For example, we suspect it may be unnecessary to mix seed throughout substrate (as opposed to the top 1–2 cm), to use 3 substrate types, or to include treatments with mixed seed sizes.

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Table 1. Treatments or treatment combinations used to create experimental foraging patches that were deployed in trials to evaluate factors influencing foraging thresholds by dabbling ducks during March–April 2010.

						Trial Number						
Name	Replicates	Seed Size	Seed Density	Seed Depth	Substrate	1	2	3	4	5	Vis Obs 1	Vis Obs 2
Control	1	Both	580	Mix	Clay-sand	X	X	X	X	X		
Deep Depth	3	Both	580	Deep	Clay-sand	X	X	X				
Shallow depth	3	Both	580	Shallow	Clay-sand	X	X	X	X	X		
Mixed Depth	3	Both	580	Mix	Clay-sand	X	X	X	X	X		
Clay Substrate	3	Both	580	Mix	Clay	X	X	X	X	X		
Sand Substrate	3	Both	580	Mix	Sand	X	X	X	X	X		
High Density Large Seed	3	Large	1,120	Mix	Clay-sand	X	X	X	X	X		
High Density Small Seed	3	Small	1,120	Mix	Clay-sand	X	X	X	X	X		
Low Density Large Seed	3	Large	350	Mix	Clay-sand	X	X	X	X	X		
Low Density Small Seed	3	Small	350	Mix	Clay-sand	X	X	X	X	X		
Medium Density Large Seed	3	Large	580	Mix	Clay-sand	X	X	X	X			
Medium Density Small Seed	3	Small	580	Mix	Clay-sand	X	X	X	X	X		
High Density Mixed Millet	3	Small	1,120	Mix	Clay-sand						X	X
High Density Mixed Rice	3	Large	1,120	Mix	Clay-sand						X	X
High Density Sand Millet	3	Small	1,120	Mix	Sand						X	X
High Density Sand Rice	3	Large	1,120	Mix	Sand						X	X

Table 2. Waterfowl behavior at GUD trial plots and visual obstruction plots during March–April 2010. Reported as mean percent time in each activity as determined by scan sampling.

	Trials 1–5			Visual Obstruction Trials 1–2		
Activity	Total	Male	Female	Total	Male	Female
Feed	55.5	52.7	59.4	56.0	53.8	59.0
Rest	16.4	17.0	15.6	16.5	15.6	17.7
Other	6.6	7.1	5.8	5.9	6.1	5.5
Social	1.9	2.2	1.4	2.8	3.5	1.9
Locomotion	12.8	13.6	11.6	13.9	14.9	12.4
Alert	6.9	7.4	6.2	5.0	6.1	3.5

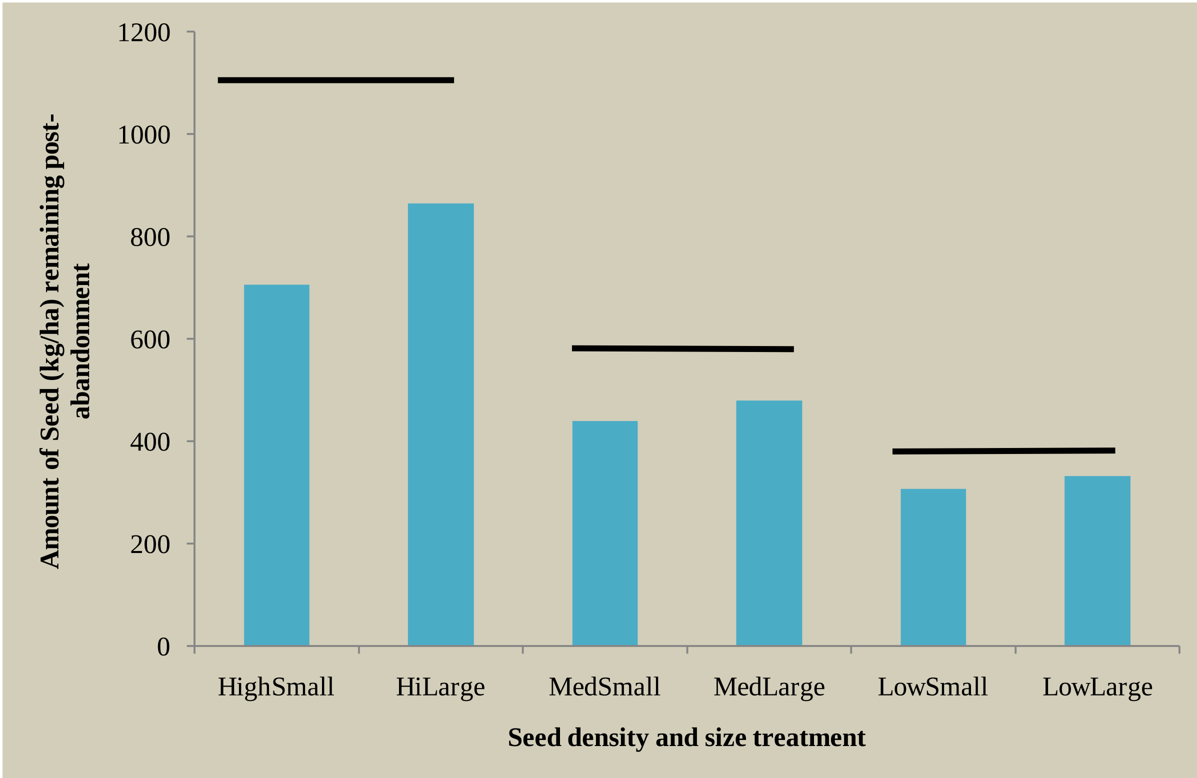

Figure 1. Seed depletion by density and seed size. Horizontal lines indicate initial values (1,120, 580, and 350 kg/ha).

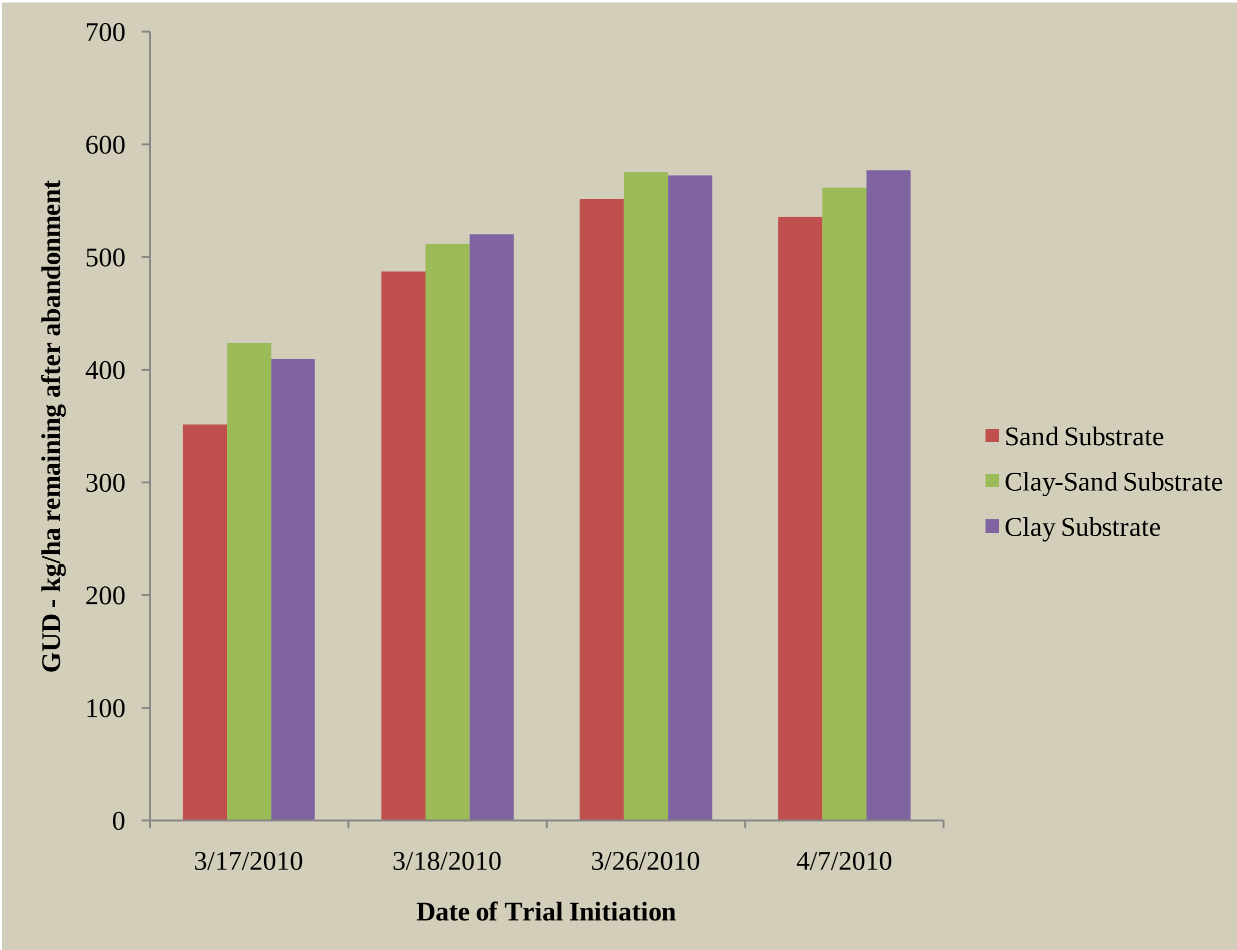

Figure 2. Seed densities following dabbling duck abandonment of foraging patches by substrate type and trial start date during March–April 2010.

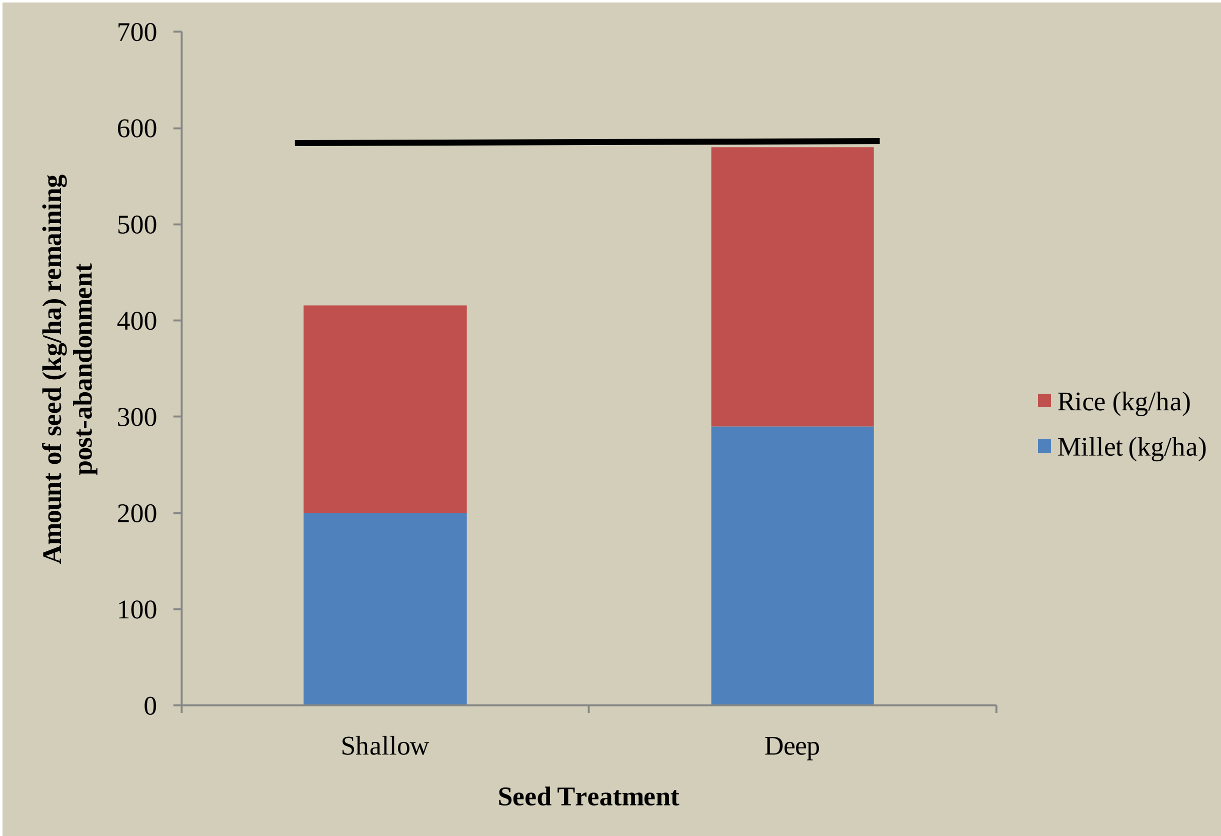

Figure 3. Seed depletion by dabbling ducks at 2 seed depths in foraging patch substrate. Horizontal line indicates initial seed density (580 kg/ha).

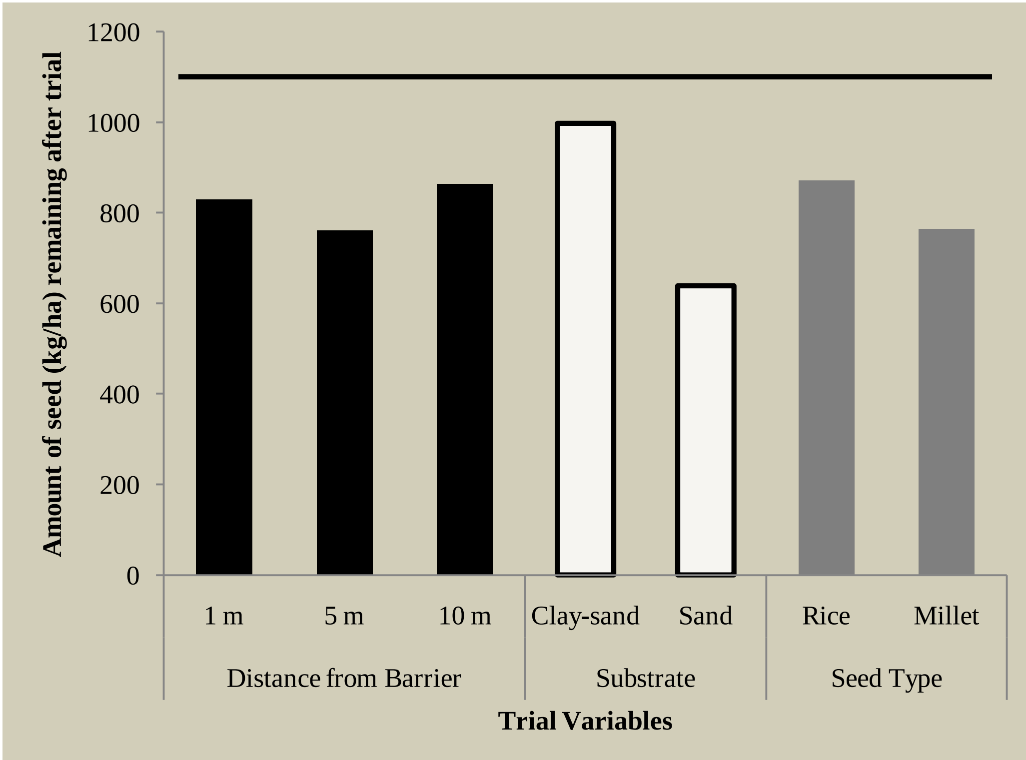

Figure 4. Seed depletion by foraging dabbling ducks associated with visual obstruction trials during March–April 2010. Horizontal line indicates initial seed density (1,120 kg/ha).