Evaluating Upland Habitat Management at the Grizzly Island Wildlife Area: Effects on Dabbling Duck Nest Density and Nest Success

Year 1 Baseline Report

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BACKGROUND AND PROBLEM STATEMENT

The Grizzly Island Wildlife Area is a 3,600 ha wildlife refuge managed by the California Department of Fish and Game. It resides in the Suisun Marsh of California (38º08' N, 121º59' W), and contains roughly 2,000 ha of wetlands and 1,600 ha of uplands managed for waterfowl production. A large block of these uplands (800 ha), called the 13 and 14 Field Complex, are divided into fields (13–30 ha each). Currently, these fields are dominated by non-native grasses and weeds.

Within these upland fields, dabbling ducks have historically nested at some of the highest densities ever recorded within non-island habitat in North America (McLandress et al. 1996, Ackerman 2002a,b, Ackerman et al. 2003a,b,c, Ackerman et al. 2004). However, current nesting densities and nest success rates have declined to very low levels (Figures 1 & 2). This decline in duck productivity may be associated with upland vegetation quality. In the 1980s and early 1990s, the California Department of Fish and Game actively managed vegetation in several of the 13 and 14 Fields by planting varying mixes of tall wheat grass, vetch, alfalfa, perennial ryegrass, and wheat. Ducks seemed to respond positively to this active upland vegetation management and nesting densities increasing rapidly until they peaked in 1997 (Figures 1 & 2). Nest success has been highly variable in the Suisun Marsh, as it is in most duck nesting areas. However, nest success in recent years has been below the estimated 15% to 20% nest success required to maintain a stable mallard population. In fact, nest success was below 20% in 8 out of the last 9 monitoring years (Figures 1 & 2). This significant decline of nest success over time could be attributed to several factors, but the most likely explanation involves the interaction between predators, alternate prey resources, and habitat quality.

In a pro-active attempt to reverse this decline in dabbling duck nest densities and nest success, the California Department of Fish and Game, Wildlife Conservation Board, California Waterfowl Association, and USGS implemented a 5-year plan to restore habitat quality and monitor duck breeding response. The restoration plan includes (1) baseline duck nest monitoring in 2008, (2) habitat and water delivery improvements to the nesting fields in 2008-2009, and (3) monitoring duck nesting response 3 years post habitat improvement in 2010, 2011, and 2012.

This report summarizes the baseline duck nest monitoring in 2008 and our progress towards enhancing habitat within the upland nesting fields.

EXPERIMENTAL DESIGN

We are in the process of improving habitat quality in 12 of the 13 and 14 Fields (see Habitat Improvements section below). In order to determine which of the 32 fields within the 13 and 14 Field Complex that we would include in the study, we first assessed which fields could be realistically manipulated. We omitted those fields that were already actively managed with winter wheat or barley for goose hunting (fields 13H, 13I, and 14I) or for pheasants (DUHU fields 13D, 13E, 13F, and 13G), fields flooded for brood habitat (fields 13P, 14G, 14K, and 14N), fields that would be difficult to either grow the selected seed mixtures due to salinity (fields 13O and 14P) or field structure (fields 13K and 13L), and fields that have high levels of human disturbance because they are next to the main road (fields 13A, 13B, 13C, 14A, and 14B). This selection procedure left us with 12 remaining fields. We randomly assigned one of three treatments to each of these fields, with the criteria that (1) each habitat treatment must be represented at least once in the 13 Field Complex and (2) that no similar habitat treatments were adjacent to one another. The three habitat treatments included (1) control fields that will have their water conveyance updated but no other habitat improvements will be made, (2) native grasses will be planted, and (3) dense nesting cover seed mixture of mostly non-native vegetation will be planted. Control fields will have similar timing of water delivery but will be otherwise untreated. Actual seed mixtures will be determined just before planting after thorough dirt manipulation and soil testing has been completed. The resulting field selections for habitat manipulations are shown in Figure 3.

DUCK NEST MONITORING

During 2008, we monitored duck nesting in 22 fields (443 ha total) within the 13 Field Complex (13D, 13E, 13F, 13G, 13H, 13I, 13J, 13M, and 13N) and 14 Field Complex (14C, 14D, 14E, 14F, 14G, 14H, 14I, 14J, 14K, 14L, 14M, 14N, and 14O). This is well beyond the number of fields we had planned to monitor, however nesting densities were very low (see below) so we expanded out effort to record as much baseline data as possible prior to the habitat improvements.

We searched for duck nests from 1 April to 11 July 2008 following nest search procedures designed by Klett et al. (1986) and modified by McLandress et al. (1996) for this study site. Each field was searched four to five times at 3-week intervals until no new nests were found. Nest searches begun at least 2 hours after sunrise and were finished by 1400 hours to avoid missing nests due to morning and afternoon incubation recesses by females (Caldwell and Cornwell 1975, Gloutney et al. 1993). Nest searches were conducted using a 50-m nylon rope strung between two slow-moving all-terrain vehicles. Tin cans containing stones to generate noise were attached at 1.5-m intervals along the length of the rope. The rope was dragged through the vegetation, causing females to flush from their nests, thus enabling observers to locate nests by searching a restricted area. Nests were marked with a 2-m bamboo stake placed 4 m north of the nest bowl and a shorter stake placed just south of the nest bowl, level with the vegetation height. We recorded Universal Transverse Mercator coordinates for each nest site with a Global Positioning Satellite Device. Each nest was revisited on foot once every seven days, the stage of embryo development was determined by candling (Weller 1956), and clutch size and nest fate was recorded. After each visit, we covered the eggs with nest materials (i.e., down and contour feathers from the nest), as the female would have done before leaving for an incubation recess.

DUCK NEST SITE VEGETATION

For each real duck nest, we randomly picked a potential nesting site by selecting an azimuth (direction) and distance from the real nest. Azimuths were selected by randomly choosing a value from 1-360 degrees on a compass. Distances were selected by randomly choosing a distance, with the minimum potential value of 1 m and a maximum potential value of 50 m. If the randomly selected location was inappropriate, i.e. it was located on an ATV trail, than we randomly chose another azimuth and distance. At both the real and paired random nest sites, we measured the vegetation's average visual obstruction height on the day the nest was found using the methods of Robel et al. (1970). The vegetation's visual obstruction height is a reliable index of a site's vegetation biomass (Robel et al. 1970).

FIELD-LEVEL VEGETATION

We also measured vegetation height at 25 points per field, spaced evenly along a transect that bisected the field's center (Figure 4). These vegetation measurements were taken from 15 May to 13 June, and therefore are not paired with nest initiation attempts. Rather, these vegetation measurements will be used to determine whether our habitat manipulations altered the vegetation within the treatment fields.

DUCK NEST ANALYSIS

The date of nest initiation was calculated by subtracting the age of the nest when found (i.e., the number of eggs when found plus the incubation stage when found) from the date the nest was discovered (Klett et al. 1986). We calculated duck nest success for each field using Mayfield (1975) techniques modified for waterfowl (Johnson 1979). Total duck nest success was calculated using an average clutch age at hatching of 35 days. We considered a nest successful if at least one egg hatched (as determined from shell remains; Klett et al. 1986). Nests that were abandoned on the day we find them, were heavily disturbed by investigators (i.e. cracked eggs or close to ATV path), or were partially depredated by predators before the nests were found were excluded from analyses (Klett et al. 1986). To estimate full clutch size, we included only those nests that were found ≤8 days in incubation to reduce the likelihood that partially depredated nests would be included in the estimate (Ackerman et al. 2003a).

We used Mayfield nest-success rates to estimate nesting densities in each field (Miller and Johnson 1978). We divided the number of successful nests (≥1 egg hatched) by the Mayfield nest-success rate to estimate the total number of nests initiated in each field. We then divided the number of nests initiated by the field's area (ha) to determine the density of initiated nests. The Mayfield estimate takes into account the limitations of the nest searching methodology; specifically, nests depredated early in incubation are often not found, causing apparent nesting densities (number of nests found divided by area) to be underestimated.

DUCK NEST MONITORING RESULTS

Nest Density---In total, we found 312 ducks nests in 2008, including 190 mallard, 118 gadwall, 3 cinnamon teal, 1 northern shoveler, and no northern pintail nests (Figure 5). This was the first year in 21 years that we did not find a pintail nest at the Grizzly Island Wildlife Area. We also found 19 northern harrier, 5 short-eared owl, and 1 white-tailed kite nests. The duck nest abundance was about half the number we normally find with the equivalent nest searching effort. Because duck nesting densities were so low, we doubled the amount of area we searched for duck nests from 12 fields to 22 fields in an attempt to determine the cause of the low nest densities.

Mallard nest densities in 2008 were the lowest ever recorded on the Grizzly Island Wildlife Area in 21 years (Figure 1B). Mallard nest densities were only 0.62 nests per ha, whereas the long-term average was 3.63 nests per ha over the 21 year period. Gadwall nest densities in 2008 were 0.50 nests per ha, below the 21 year average nest density of 1.00 nests per ha (Figure 2B).

Nest Initiation Dates---Mean mallard nest initiation dates in 2008 were 5 May, the latest mean nest initiation date (range: 8 April to 5 May) ever recorded in 21 years at Grizzly Island Wildlife Area. Although mallards started nesting later (10% by 16 April), they did not nest later in the season (90% by 26 May), which resulted in a much shortened nesting season. The central span (10% to 90%) of nest initiations was only 40 days long, well short of the typical 49 day season over the last 21 years.

Mean gadwall nest initiation dates in 2008 were 18 May, the 2nd latest mean nest initiation date (range: 24 April to 20 May) recorded in 21 years at Grizzly Island Wildlife Area. However, gadwall's central span of nest initiation dates in 2008 (35 days) was similar to the long term average (32 days), because they nested later in the season (90% by 7 June) then they typically do (90% by 23 May).

Nest Success---Mallard nest success in 2008 was 22.3% (95% CI: 16.4%-30.9%), below the average nest success observed on Grizzly Island Wildlife Area (about 28% over 21 years; Figure 1A), but above the 15% to 20% nest success estimated that is required to maintain a stable mallard population. Gadwall nest success in 2008 was 12.2% (95% CI: 7.5%-19.7%), which ranks 4th worst nest success recorded at Grizzly Island Wildlife Area over 21 years (average was 22.2% over 21 years; Figure 2A). More importantly, gadwall nest success was below the 20% nest success estimated that is required for a stable gadwall population.

Differences Among Fields---The number of ducks nesting in each field was limited (Figure 5). We found the most duck nests in field 14E (N=32), followed by 14M, 13G, 14D, and 13M. Nesting densities were highest in field 13G and 14M. Mallard nest success was highly variable among fields, and was highest in fields 13E, 13M, and 14M. Table 1 describes in detail nest densities and nest success by field.

Table 1.

Field	Hectares	Vegetation Height (cm: mean)	Vegetation Height (cm: sd)	Mallard # Nests	Mallard Nest Success	Mallard Nest Density per ha	Gadwall # Nests	Gadwall Nest Success	Gadwall Nest Density per ha
13D	15.0	---	---	5	41.2%	0.32	4	3.0%	0.00
13E	15.0	---	---	5	72.2%	0.37	8	28.4%	0.71
13F	15.4	---	---	9	32.2%	0.81	7	7.1%	0.91
13G	15.4	---	---	15	18.7%	1.74	11	11.1%	1.17
13H	15.4	21.7	8.5	8	14.6%	0.89	6	10.6%	0.61
13I	15.5	25.9	15.0	5	15.6%	0.41	0	---	---
13J	15.0	25.0	12.5	2	26.7%	0.25	3	20.0%	0.33
13M	13.4	35.9	18.4	14	57.8%	1.04	8	10.1%	1.49
13N	11.9	19.3	8.6	4	8.0%	1.06	4	33.5%	0.50
14C	20.3	30.7	16.1	8	10.6%	0.46	2	7.5%	0.00
14D	27.5	33.0	16.3	16	21.5%	0.85	7	5.3%	0.00
14E	27.5	18.9	9.8	19	14.6%	1.00	13	8.8%	1.24
14F	27.5	21.0	9.9	8	4.9%	0.75	9	13.0%	0.56
14G	24.3	---	---	6	11.7%	0.35	4	0.9%	4.40
14H	27.5	25.4	15.3	3	17.4%	0.21	3	0.0%	0.00
14I	27.5	20.8	6.9	0	---	---	2	0.0%	0.00
14J	28.3	17.6	6.9	11	0.2%	0.00	3	0.1%	0.00
14K	21?	---	---	6	8.7%	0.55	4	6.8%	0.70
14L	22.4	17.5	8.5	3	15.8%	0.28	2	3.0%	0.00
14M	16.6	22.5	9.5	20	53.4%	1.47	7	77.2%	0.39
14N	18.4	---	---	9	22.1%	0.98	2	100.0%	0.11
14O	21.9	24.8	10.3	10	19.3%	0.71	3	15.8%	0.29
ALL FIELDS	**442.5**	**24.0**	**13.0**	**190**	**22.6%**	**0.62**	**118**	**12.2%**	**0.50**

Nest Site Vegetation---Both mallard and gadwall selected taller vegetation than was considered available. Figure 6 shows random sites where vegetation was measured in relation to nests. Nest site vegetation at mallard nests (40.6±1.1 cm) was taller than at paired sites chosen randomly (34.0±1.6 cm; t_{182}=4.10, P<0.0001; Figure 7). Similarly, nest site vegetation at gadwall nests (33.9±1.1 cm) was taller than at paired sites chosen randomly (28.2±1.6 cm; t_{107}=3.35, P=0.001). Additionally, the difference between the nest site's and random site's vegetation heights were negatively correlated with the vegetation height of the random site for mallards (N=183, R^2=0.60, P<0.0001) and gadwall (N=108, R^2=0.60, P<0.0001; Figure 8). This indicates that (1) when vegetation was scarce, ducks selected taller vegetation and (2) when vegetation in the immediate vicinity (<50 m) was tall, ducks selected shorter vegetation. In general, ducks tended to nest in vegetation around 20-50 cm in height (Figure 9).

HABITAT IMPROVEMENTS

Native Grass and DNC Fields---Fields 13M, 13N, 14C, 14E, 14H, 14J, 14M, and 14L were treated with Telar XP (2 oz/acre) where pepperweed (*Lepidium latifolium*) was present from April-May 2008 (Figures 3 & 10). Treatment method included boom and boomless spray equipment mounted on a Kubota RTV. Wind conditions greatly limited the opportunity to apply chemical and lengthened the application process. This will likely result in variable success amongst treated fields. Areas with common reed (*Phragmites australis*), mainly ditch banks, were treated with Quali-Pro (5 qts/acre) from late July to early August 2008. The chemical was applied with a handgun mounted to a Kubota RTV.

Mechanical manipulation began in August 2008 after chemical treatments were allowed to settle and take effect. All fields were mowed as low as possible with a flail mower, plowed once to a depth 12"-18", then disced twice with a finish disc. V-ditches approximately 18" deep were also cut every 50' from top to bottom and connected to the main drain ditch of each field. It is our hope that these v-ditches will improve drainage, thereby harnessing the ability of natural runoff to help leach soil salts throughout the winter.

Cereal Grain Fields---Fields 13H, 13I, and 14I were treated with Telar XP (2 oz/acre) where pepperweed was present from April-May 2008. Treatment method included boom and boomless spray equipment mounted on a Kubota RTV. Wind conditions greatly limited the opportunity to apply chemical and lengthened the application process. This will likely result variable success amongst treated fields.

The existing vegetation in these fields was primarily annual ryegrass (*Lolium* sp.) and did not require plowing to deal with the thatch layer. Therefore, these fields were only disced twice with a finish disc. Based on preliminary soil samples these fields also had significantly less soils salts than other fields, therefore they did not require v-ditches in order to assist in the process of leaching soil salts.

Control Fields---Fields 13J, 14D, 14F, and 14O were treated with Telar XP (2 oz/acre) where pepperweed was present from April-May 2008 (Figures 3 & 10). Treatment method included boom and boomless spray equipment mounted on a Kubota RTV. Wind conditions greatly limited the opportunity to apply chemical and lengthened the application process. This will likely result in variable success amongst treated fields.

Control fields were not disced or otherwise manipulated.

Water Conveyance---Three existing drain ditches were cleaned in the 14 fields (Figure 10) to improve drainage. A section of new ditch was excavated along field 14O to improve drainage as well. The northern levee at the southeastern most end of Shortcut Ditch was repaired and elevated from dirt excavated from adjacent fields near the existing drain ditches in a manner that will improve drainage of the fields.

Baseline Vegetation Photographs---Please see **Attachment 1** for photograph station locations and photographs of each field during spring 2008 showing baseline vegetation before habitat restoration improvements have begun. We will continue taking photographs at these sites each year to document restoration success.

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FIGURES

Figure 1. Mallard (A) nest success (Mayfield estimate) and (B) nest density per ha (Mayfield estimate) at the Grizzly Island Wildlife Area from 1985 to 2008; no nest monitoring was conducted in 2005, 2006, or 2007 due to funding restrictions.

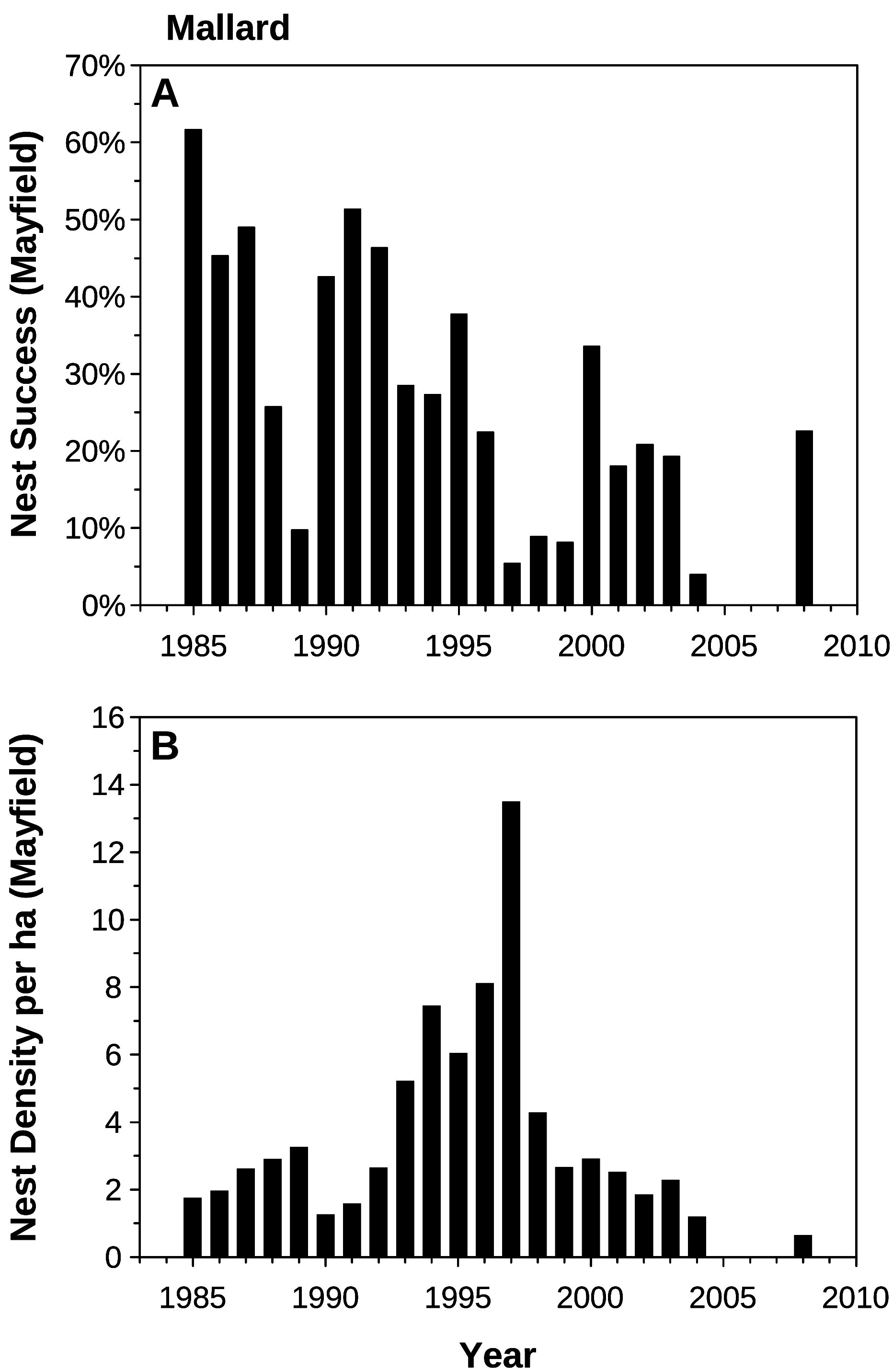


Figure 2. Gadwall (A) nest success (Mayfield estimate) and (B) nest density per ha (Mayfield estimate) at the Grizzly Island Wildlife Area from 1985 to 2008; no nest monitoring was conducted in 2005, 2006, or 2007 due to funding restrictions.

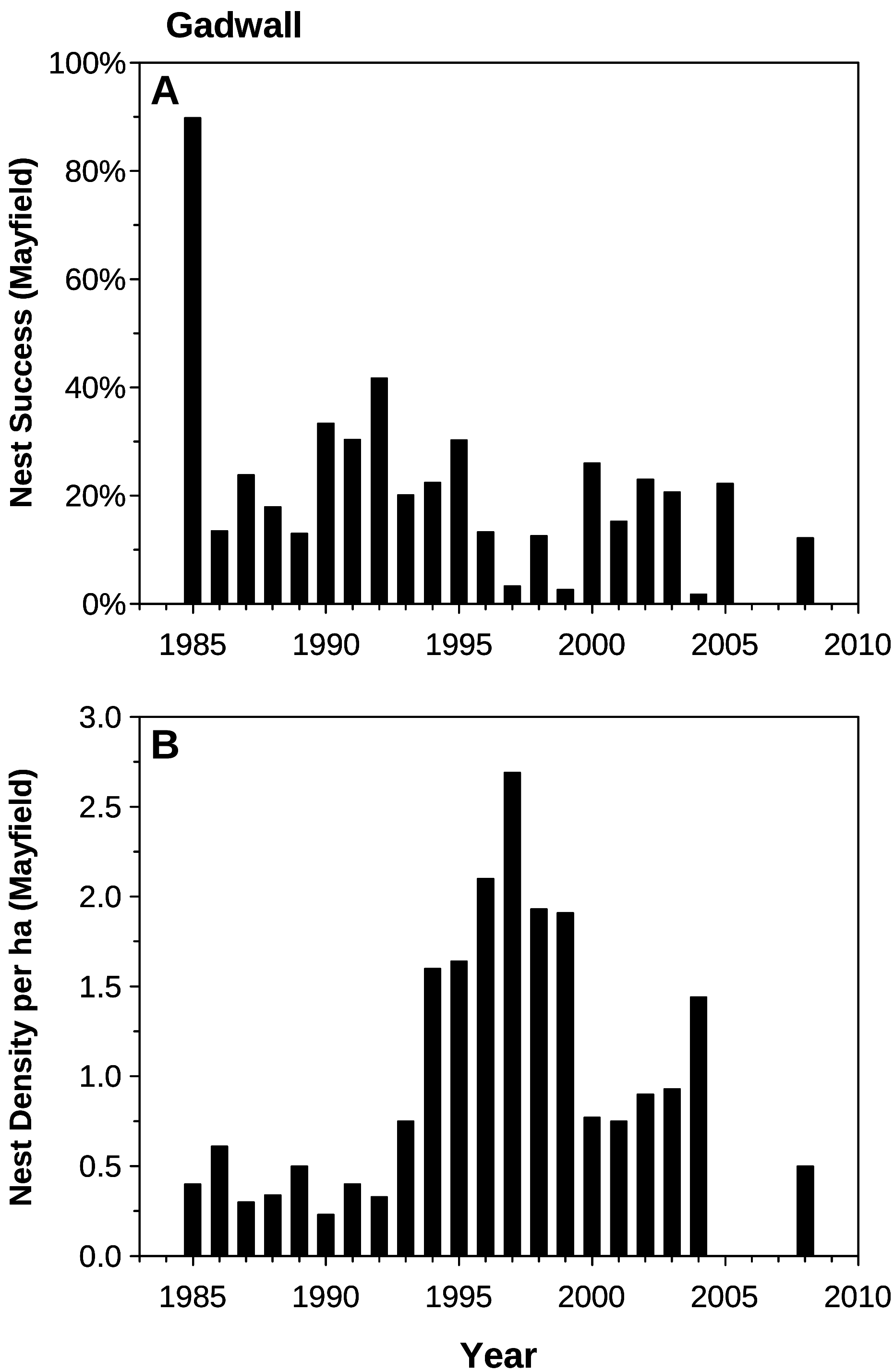


Figure 3. Study area map depicting the upland nesting fields at the Grizzly Island Wildlife Area and those fields that will be part of the habitat restoration program initiated in 2008.

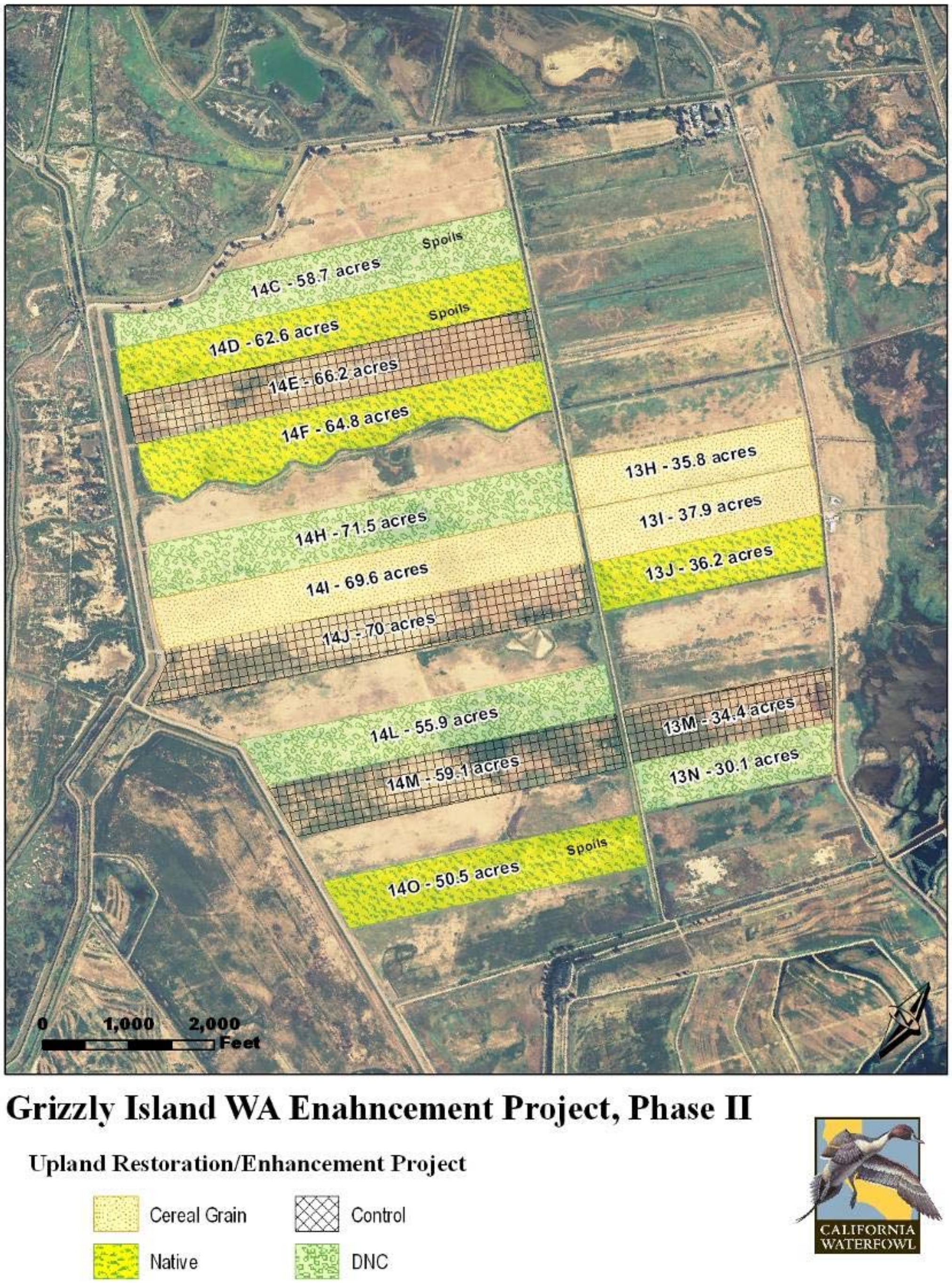


Figure 4. Sites where vegetation was measured in the fields that will be part of the habitat restoration program initiated in 2008.

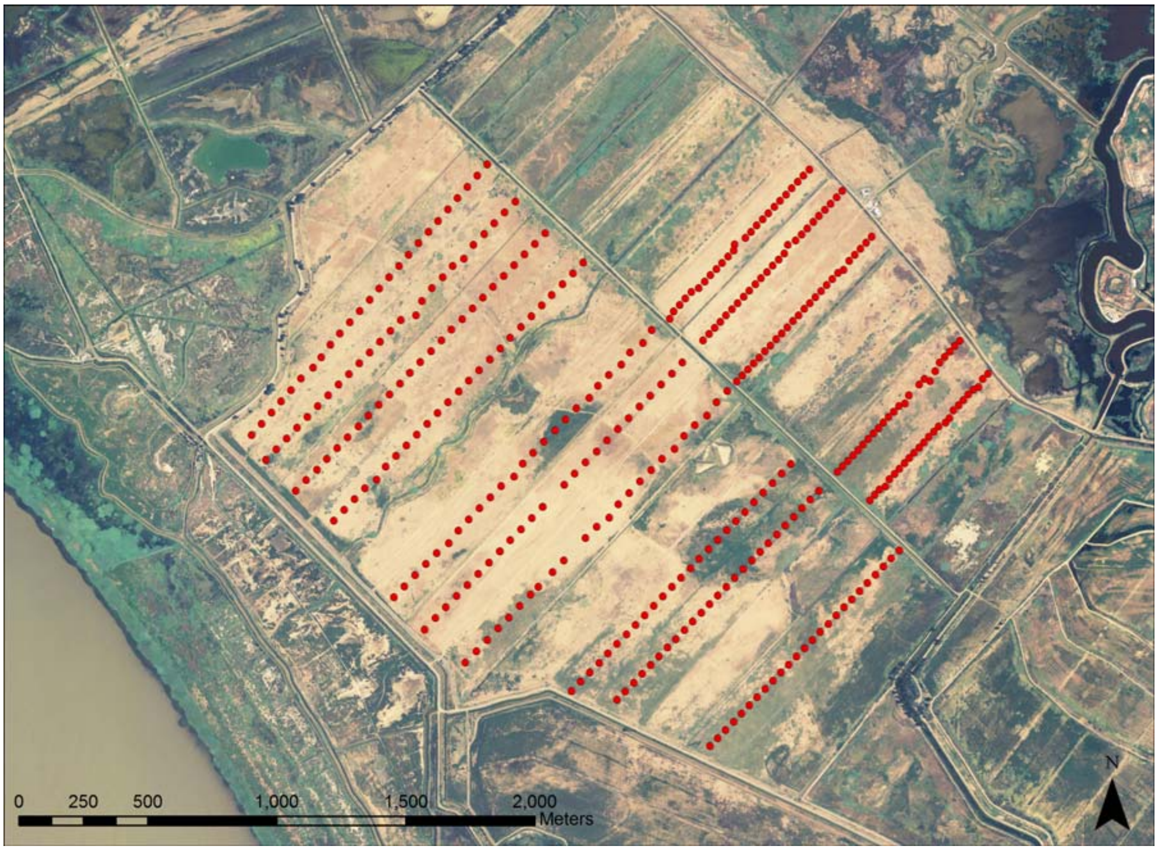


Figure 5. Locations of duck and raptor nests found on the Grizzly Island Wildlife Area in 2008.

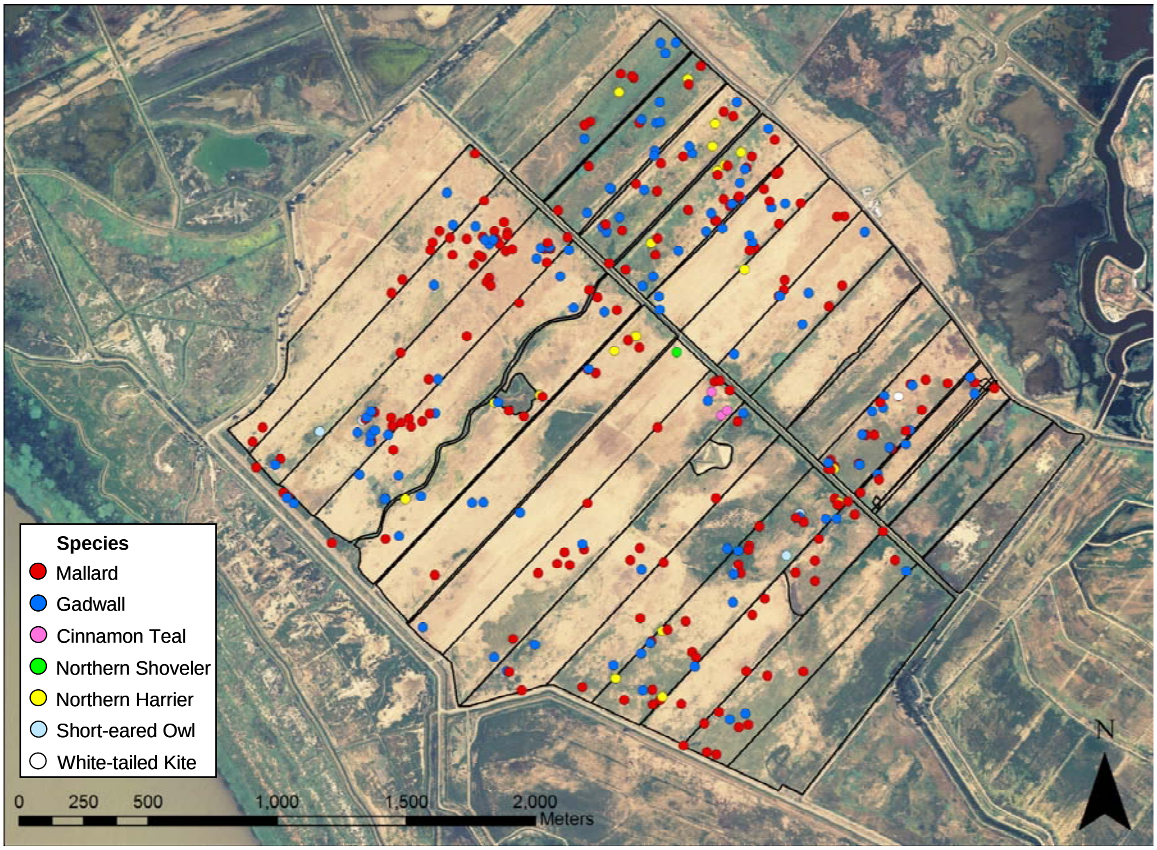


Figure 6. Locations of real nests and paired, random sites considered available to birds for nesting at the Grizzly Island Wildlife Area in 2008. The random sites were used to assess nest site selection of vegetation parameters.

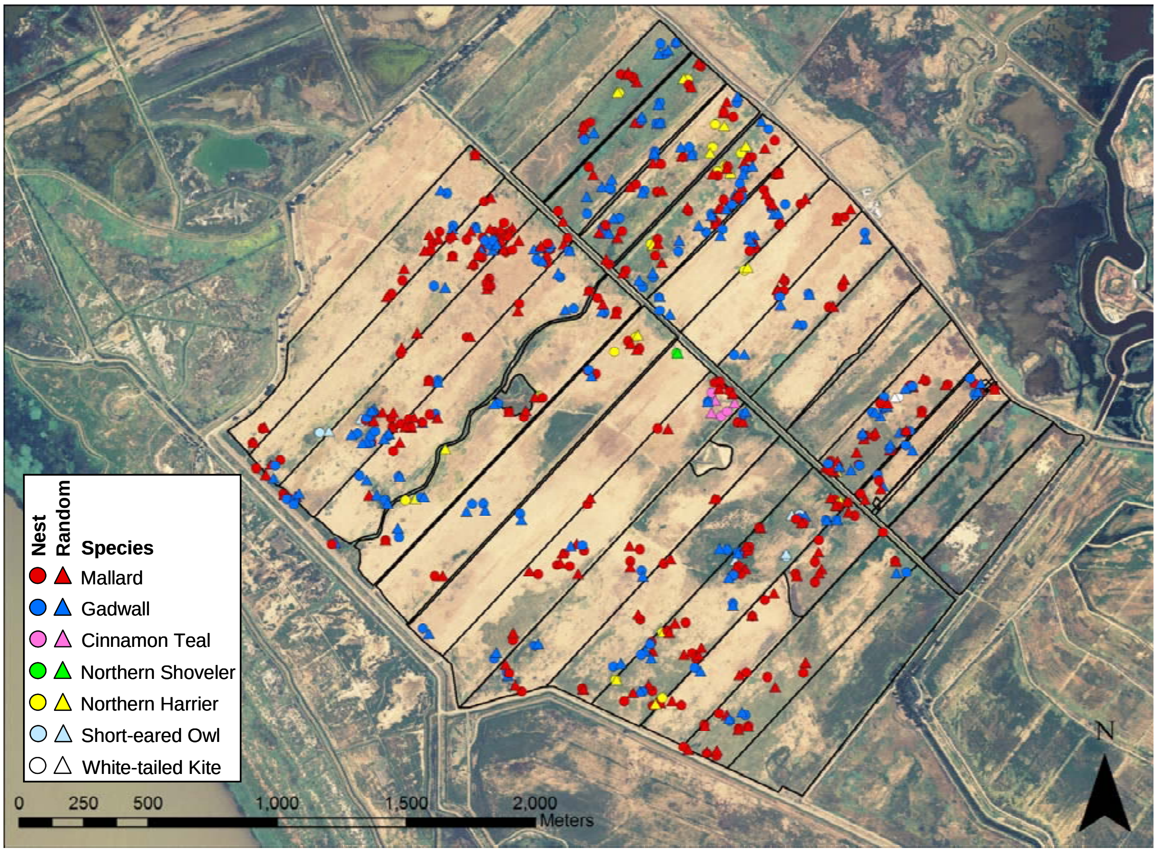


Figure 7. Nest site vegetation at mallard (t_{182}=4.10, P<0.0001) and gadwall (t_{107}=3.35, P=0.001) nests was taller than paired random potential nest sites at the Grizzly Island Wildlife Area in 2008.

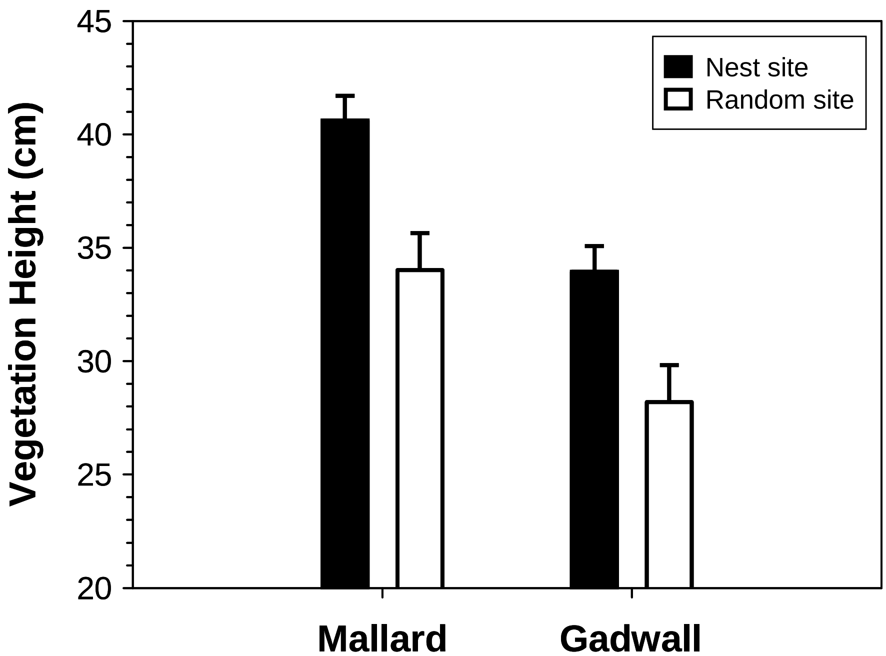


Figure 8. Nest site vegetation height minus the vegetation height at a paired random location in relation to vegetation height at the random location for mallard (A) and gadwall (B) at the Grizzly Island Wildlife Area in 2008. Positive values >0 indicate selection for taller vegetation whereas negative values <0 indicate selection for shorter vegetation.

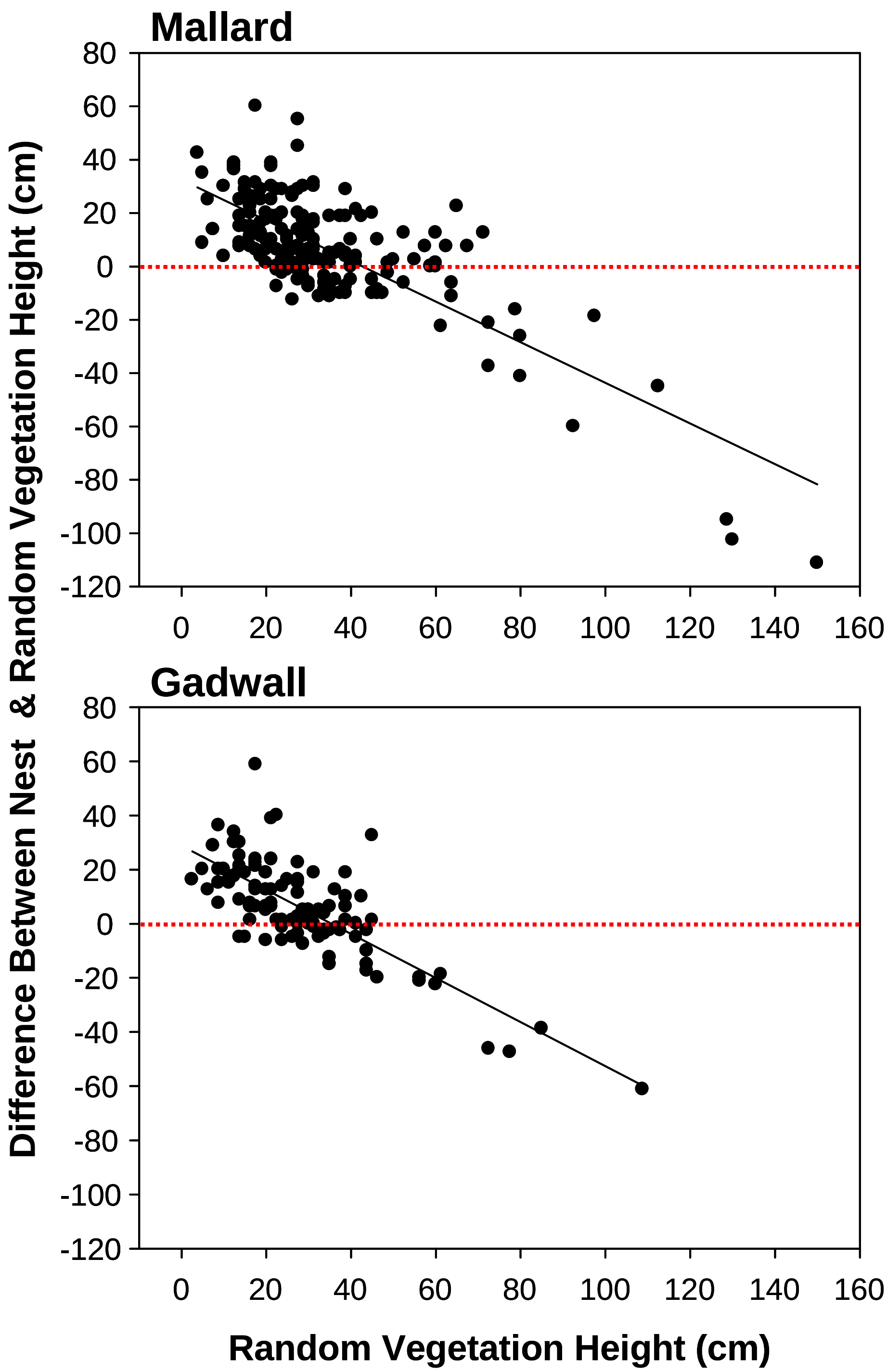


Figure 9. Histograms depicting the distribution of vegetation heights (cm) at mallard (left panels) and gadwall (right panels) nests and random sites at the Grizzly Island Wildlife Area in 2008.

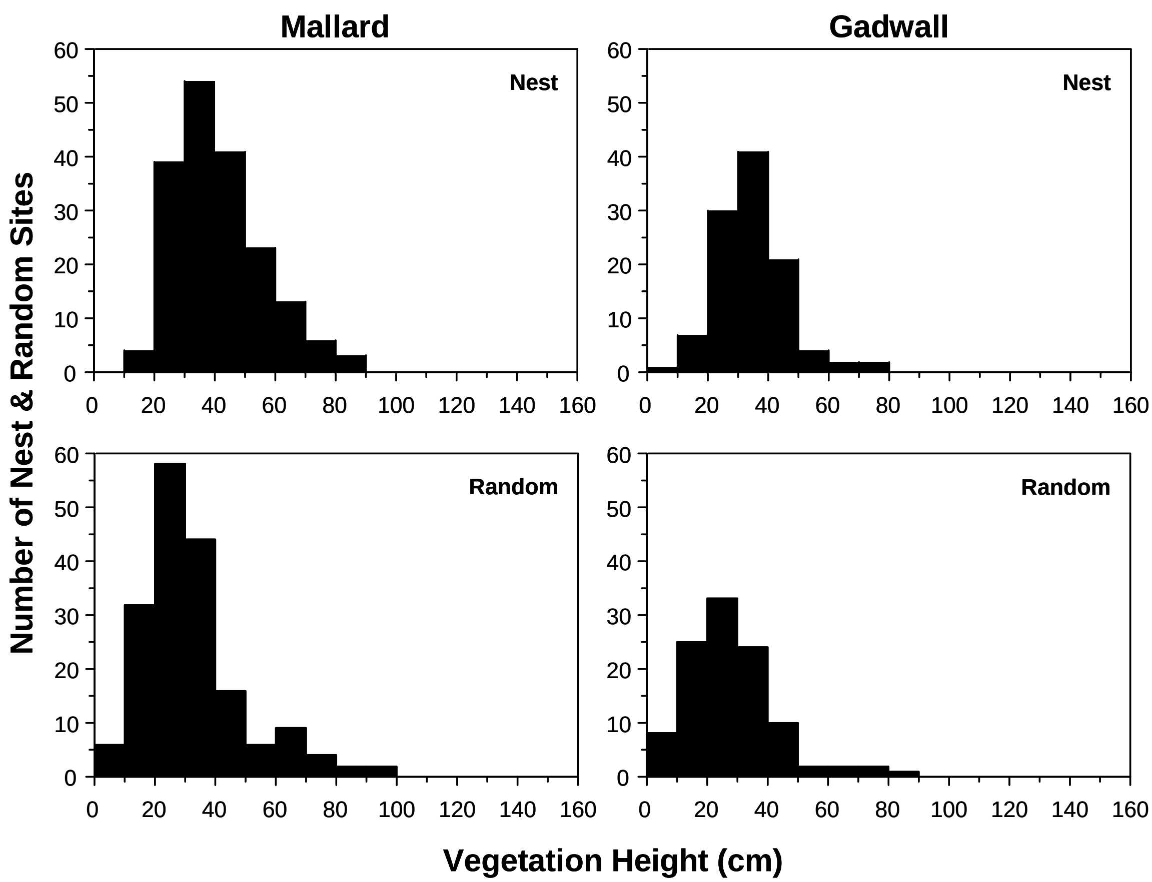
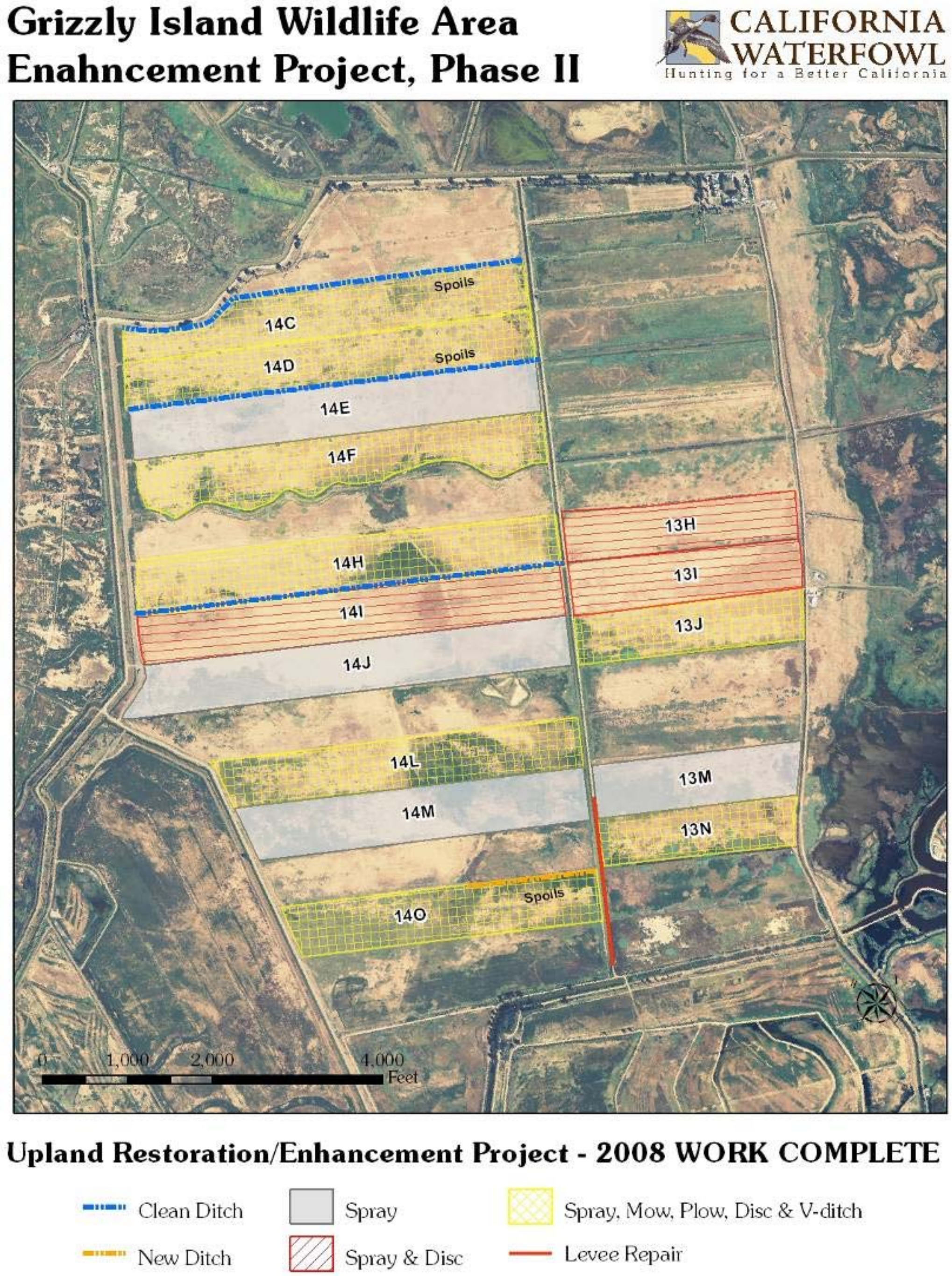
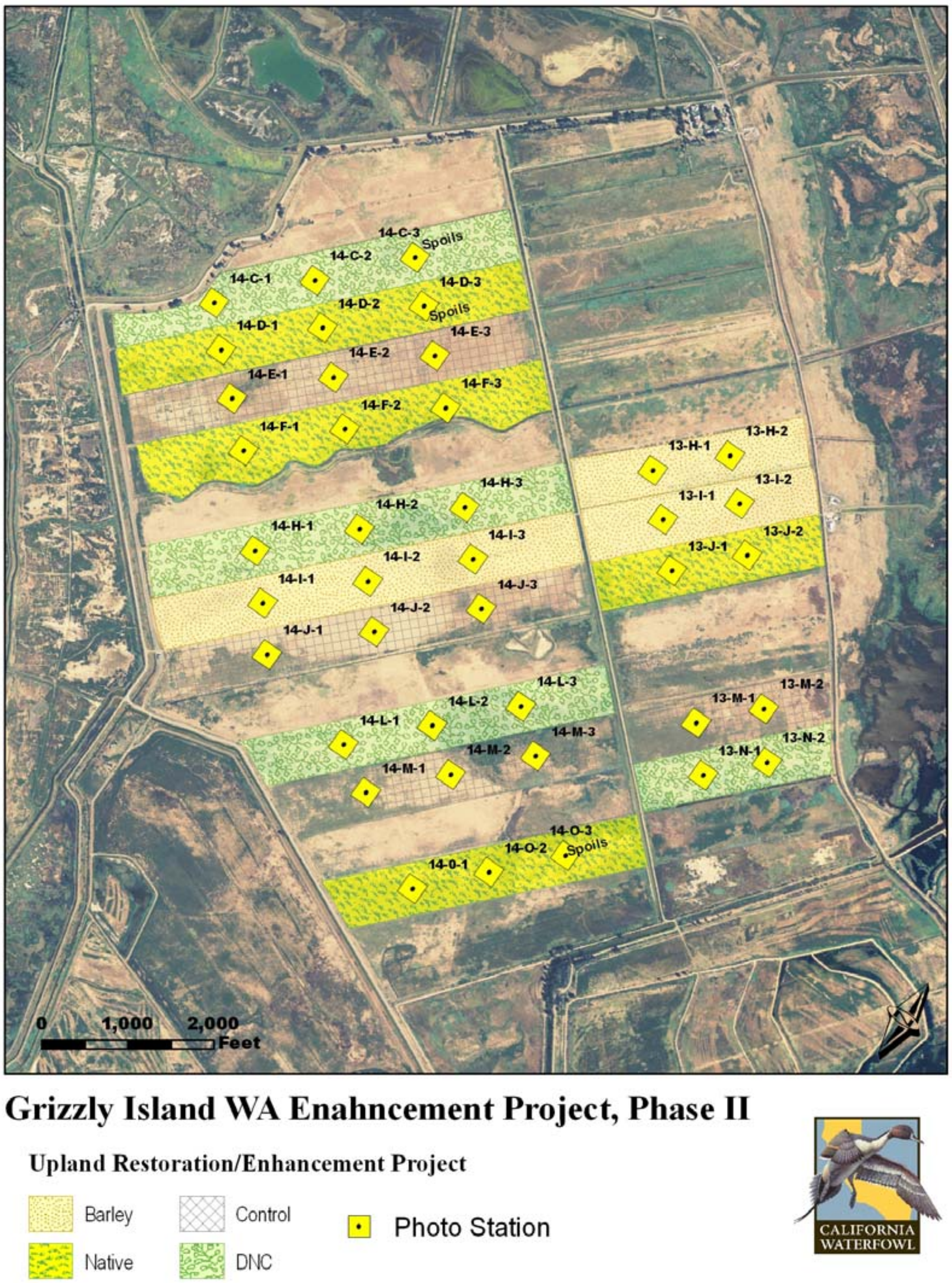


Figure 10. Study area map depicting habitat restoration progress from July to December 2008.



Attachment 1. Photograph station locations and photographs of each field depicting baseline vegetation in spring 2008 before treatment began. All photographs were taken 15-17 April, 2008 looking north/northeast down the length of the field.




13H-2


13I-2


13J-2


13M-2


13N-2


14C-2


14D-2


14E-2

14F-2

14H-2


14I-2


14J-2


14L-2


14M-2


14O-2