

Point Reyes National Seashore
Contraception Program 2001

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Summary

The 2001 contraceptive boosting season at PORE began on June 5 and ended on August 6. In 33 field days, 47 female tule elk were darted with porcine Zona Pellucida (pZP), an immunocontraceptive vaccine known to prevent conception in Tomales Point elk (Shideler 2001). The darting crew was unable to dart 2 individuals because of avoidance behavior, presumably learned in the 5 years of the contraceptive program. The number of hours expended per successful darting event were reduced from 9.3 hours in 2000 to 6.3 in 2001. This improved darting efficiency, in spite of the observed increased wariness in target animals, as well as improved dart retrieval, are likely the result of having one PORE employee responsible for all of the shooting. Monitoring of collared cow natality throughout the summer of 2001 suggest that last year's (summer 2000) contraceptive program resulted in statistically significant decreases in calving rates between treated and control animals. However, the field efficacy of pZP, as used in the PORE boosting protocol, was less than the drug's efficacy as described by U.C. Davis researchers in 1997-2000, and was variable from year to year. The estimated number of calves prevented with contraception was 1.6 in 1999, 15.6 in 2000 and 13.3 in 2001. This variability is likely due to factors effecting the mechanics of darting increasingly wary elk cows in the field rather than due to any change in drug efficacy. The estimated minimum cost of the 2001 program was \$16,127 or \$343 per treated cow and \$972 per 2001 calf prevented. The success of the darting program this year was possible because of the dedication of Morgan Horses Ranch, elk program volunteers, PORE Vegetation Management, Law Enforcement, and Interpretation staff.

Report Contraception Program 2001.doc

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01/31/02

Methods

This was the fifth year of the elk contraceptive program at Tomales Point, and the second year the program was administered and coordinated by PORE staff. Animals boosted this year were captured and first inoculated with porcine Zona Pellucida (pZP) as part of a University of California, Davis research project, in the summers of 1997-1998.

In contrast to last year's program, one individual, Gary Sharlow, a GS/5 biotechnician, darted all cows in 2001. The darting biotechnician was trained in wildlife capture and handling and met qualification requirements for NPS-PORE firearm use. Along with a single horse/rider pair each day, the darter spent 9-10 hours, four days per week, at Tomales Point. In 33 field days, 47 elk were darted using 1 cc. darts containing 65 µg. of pZP and 0.5 cc. of Freund's Incomplete Adjuvant (see Table 1 for a list of treated animals). A Pneu-Dart® rifle was used for shooting darts from 25-45 yards. The protocol developed in 2000 for boosting was followed again this year¹ (Appendix 1). A range finder was used to measure distance before each shot. Data sheets were filled out for each boosted animal with information on date and time, shooter's initials, presence or absence of a calf, location of the dart hit, whether the dart was retrieved and had discharged, and any perceived problems.

Daily boosting at Tomales Point involved 1 horse and rider along with the darting biotechnician. The horse/rider team acted as cover for the shooter as he approached to within shooting range (<45 meters) of the target animal(s). Because treated elk now frequently move away from them, the horse and rider provided less assistance this year than in past years. With increasing frequency, the horse and rider were used this summer solely as a diversion, while the darter stalked a target from behind brush.

A concerted effort was made this summer by resource staff and interns to identify calves born in spring 2001 to collared (treated and control) cows. Calves of the year were only attributed to collared dams if they met one or more of the following requirements:

1. They were observed nursing from the collared animal
2. They were being groomed by the collared animal
3. They were observed at some distance (usually >50 meters) from a group, traveling with the collared cow.

Results of 2001 Boosting Season

47 elk cows were darted successfully during 2001, 18 animals in June, 28 in July and 1 cow in August (Table 1). As the 2001 field season consisted of 33 days, this constitutes a success rate of 1.4 animals darted per day, or 6.3 hours per successfully darted cow. This is 33% less effort than last year's rate of 9.3 hours per successfully darted cow. Darting effort was less in July than in June or August. Of the 47 successful shots, 26 (55%) were fired from a distance of greater than 35 meters. This contrasts with 33% of last year's shots (n= 43) fired from a distance of greater than 35 meters.

¹ One step in the 2000 darting protocol was modified this year. Instead of plugging the darts with Chapstick™ or an antimicrobial ointment, the needles were left open. This was done in an effort to prevent abscess formation. There were no observed premature dart discharges.

Table 1:Elk Cows Darted with pZP June-August 2001

collar	Date of treatment	Treatment	Dart Dose	Dart Site
BBO	7/31/2001	PZP + FIA	FULL (65 UG)	R HIP
BOY	6/7/2001	PZP + FIA	FULL (65 UG)	R HIP
BYO	8/6/2001	PZP + FIA	?	R HIP
GBO	6/26/2001	PZP + FIA	FULL (65 UG)	R GLUTEALS
GGO	7/9/2001	PZP + FIA	?)	R HIP
GOB	6/25/2001	PZP + FIA	FULL (65 UG)	L LEG, LOW
GOG	7/17/2001	PZP + FIA	FULL (65 UG)	L HIND
GOO	6/14/2001	PZP + FIA	FULL (65 UG)	L HIP
GRO	7/17/2001	PZP + FIA	FULL (65 UG)	L HIP
OBB	7/23/2001	PZP +FIA	FULL (65 UG)	R HIND
OBO	7/25/2001	PZP + FIA	FULL (65 UG)	R HIP
OBR	6/5/2001	PZP + FIA	FULL (65 UG)	R HIP UPPER THIGH
OBY	6/25/2001	PZP + FIA	FULL (65 UG)	L HIP
OGG	7/9/2001	PZP + FIA	FULL (65 UG)	R HIP
OGO	7/18/2001	PZP + FIA	FULL (65 UG)	L HIP
OGR	7/23/2001	PZP + FIA	FULL (65 UG)	R HIP
OGY	7/23/2001	PZP + FIA	FULL (65 UG)	L HIP
OOB	6/4/2001	PZP + FIA	FULL (65 UG)	L HIP
OOG	6/26/2001	PZP + FIA	FULL (65 UG)	R GLUTEALS
OOO	6/14/2001	PZP +FIA	FULL (65 UG)	R HIP
OOR	6/6/2001	PZP + FIA	FULL (65 UG)	R HIP
Ooy	7/2/2001	PZP + FIA	FULL (65 UG)	L HIP
ORB	6/18/2001	PZP + FIA	FULL (65 UG)	R HIP
ORG	6/21/2001	PZP + FIA	FULL (65 UG)	R HIP
ORO	7/24/2001	PZP + FIA	FULL (65 UG)	L HIP
ORY	7/10/2001	PZP +FIA	FULL (65 UG)	L HIP
OYB	6/7/2001	PZP+ FIA	FULL (65 UG)	L HIP
OYO	7/23/2001	PZP + FIA	FULL (65 UG)	L HIND
OYR	6/26/2001	PZP + FIA	?	L HIP
OYY	7/24/2001	PZP + FIA	?	R HIP
RBO	6/21/2001	PZP + FIA	?	L HIND
ROG	6/5/2001	PZP + FIA	FULL (65 UG)	L DORSAL THURL
ROO	7/24/2001	PZP + FIA	FULL (65 UG)	R HIP
ROY	7/9/2001	PZP +FIA	FULL (65 UG)	R HIND
RYO	6/13/2001	PZP + FIA	?	L HIP
WOY	7/16/2001	PZP + FIA	FULL (65 UG)	L HIP
WYY	7/3/2001	PZP + FIA	FULL (65 UG)	L HIP
YBO	7/3/2001	PZP + FIA	FULL (65 UG)	L HIP
YGO	7/31/2001	PZP + FIA	?	R HIP
YOB	7/3/2001	PZP + FIA	FULL (65 UG)	L HIP
YOO	7/10/2001	PZP + FIA	FULL (65 UG)	L HIP
YOR	7/12/2001	PZP + FIA	FULL (65 UG)	R HIP
YOW	7/25/2001	PZP + FIA	?	R HIP
YOY	6/6/2001	PZP + FIA	FULL (65 UG)	R HIP
YRO	7/10/2001	PZP +FIA	FULL (65 UG)	R HIND
YWO	7/9/2001	PZP + FIA	?	L HIND
YYO	7/31/2001	PZP + FIA	FULL (65 UG)	R HIP

Darts were retrieved in 92% of successful shots compared to 65% of the time in 2000. All retrieved darts had discharged the full drug dose except in one case in which the needle was plugged with bone and the dart apparently contained a full dose (BBO on 6/19/01). This animal was subsequently redarted successfully and was not observed to be lame. In 9 instances where darts could not be retrieved and tested for full discharge, administration of the full pZP dose cannot be assured.

Three of the 47 cows (6%) successfully darted in 2001 were shot in suboptimal anatomical locations other than the rump and hindquarters; 2 in bone (1 hip and 1 perineal area), and 1 cow was darted low in the left flank. All 3 were monitored visually in subsequent months and were observed in good physical condition.

Unsuccessful shots in 2001 were not documented on data sheets and lost darts from missed shots would suggest that more than 20 unretrieved, potentially "live" darts were left this year on the elk range.

Results of 2001 Natality Monitoring

The duration of action of pZP is thought to be no more than one year. In the form in which the drug has been utilized at Tomales Point, effective contraception requires at least one "booster" injection, using Freund's incomplete adjuvant (FIA), ~ 3 weeks after the primary dose in Freund's complete adjuvant (FCA) (Stoops et al 2001, Shideler 2001, Turner et al 1996). Thereafter, yearly boosters of pZP in FIA should result in contraception in >90% of treatment animals (Shideler, 2001). It is possible that animals that had missed a booster within the 2 years previous to a rut season might not have sufficiently high levels of anti-ZP antibodies to prevent conception. Therefore, to be conservative, comparisons of calving rates between treated and control groups should limit the definition of "treated" females to those cows who received 2 injections the first year and were treated for at least 2 years previous to the calving season being monitored. For cows calving in 2001, only those boosted in both 1999 and 2000 will be considered as "treated", while only those untreated since their capture (never treated) will be considered "controls".

Through intensive visual monitoring of collared cows during summer 2001, 9 of 16 control cows (mean calves/cow=0.56) were confirmed with calves of the year. Eight of 38 contracepted cows (mean calves/cow=0.21), boosted with pZP in both 1999 and 2000, were also confirmed with calves. Using a 2-tailed z statistic to compare mean calves/cow, the null hypothesis (no difference in the calving rates between treated and untreated animals) is rejected ($p \leq 0.08$). If the calving rate in control cows is used as the herd calving rate, the number of 2001 calves that were prevented by contracepting 38 animals in 2000 is 13.3 ($[0.56 \times 38] - 8 = 13.28$). This compares with an estimated 1.6 and 15.6 calves prevented in the 1999 and 2000 calving seasons respectively (Table 2).

To test the null hypothesis that dart retrieval was not correlated with effective contraception (i.e. unretrieved darts were as likely or less likely than retrieved darts to result in inadequate contraception), we compared natality in those animals whose darts were retrieved and checked in 2000 versus those whose darts were lost. One of the 14 treated cows (7%) whose darts were lost in 2000 calved in 2001. In

comparison, 7 of 24 treated cows (29%) whose darts were retrieved in 2000 had calves in 2001. The null hypothesis is not rejected at a level of significance $\alpha = 0.05$.

In 2000, 3 cows (7%) were darted in suboptimal anatomical areas and were later seen to be in good condition and have all survived to the present. Two of these animals (YGO and YOR) were boosted this past summer and neither was seen to have calved in 2001. One of these animals (RGO) was darted in the flank in 2000, calved in 2001 and could not be boosted this year. The difference in 2001 calving rates between 2000 treated cows darted in optimal versus suboptimal areas was not significant ($\alpha = .05$).

Program Costs

\$16,127 was expended for the 2001 boosting program (Table 3). This figure should be considered a minimum estimate since it does not include time spent on the program by the supervising wildlife biologist, other wildlife biotechnicians, other Resource Management and Law Enforcement staff. As in 2000, the program would likely have cost 25-30% more without hours donated by volunteers.

Safety, Visitors and Interpretation

There were no accidents involving staff, volunteers, visitors or horses during this year's boosting. No abscesses were observed, up to 5 months post-treatment, at year 2001 injection sites.

As in 2000, a sign describing the contraceptive program was posted at the Tomales Point trailhead. Most visitors appeared curious about the program and supportive of it once details were explained. The PORE contraception program was featured in a KPIX television news story (6/28/01) and in a San Francisco Chronicle article (Harris 2001).

Conclusions and Recommendations

During the 2001 contraceptive darting season, PORE staff were successful in boosting almost all of the designated target animals without injury to humans, horses or wildlife. The program attracted positive attention from the visiting public and the local media.

Elk cows at Tomales Point, however, are becoming more difficult to dart each year. Aging radio-collars on control and treatment animals are becoming more difficult to read and transmitter batteries are expiring. The percentage of all shots taken from beyond the recommended 35 meter distance increased this year, in spite of efforts by the darting crew to approach closer. The two target animals that were not darted this year clearly avoided the darting team. The horse and rider are becoming less effective tools for screening the darter and on many occasions, caused target elk to flee without the darter being present. It is apparent from repeated observation that, although in the past elk have allowed horses to approach closer than they would allow people on foot, treated animals have learned to avoid horses. It is questionable whether horses would be of any use at all should the current group of treated animals be boosted in future years.

In spite of observed increased wariness in treated animals, darting efficiency improved this year, as evidenced by: 1. fewer hours spent per animals darted and, 2. an increased number of darts retrieved. This may be due to a number of factors. Gary Sharlow, the biotechnician responsible for all the shooting, had more firearm accuracy training than most of the darters in 2000. He also had recent experience in reading the color bands on the elk collars, some of which are nearly illegible after 3-4 years of deployment. In addition, because only one shooter worked all summer, the "learning curve" required of all darters at the beginning of the season was not repeated for multiple shooters. It is possible, although difficult to confirm from data collected, that more animals in 2001 were darted in grassland and low cover habitat where darts were easier to retrieve (see below). It would seem probable, however, that more open cover would result in animals observing the shooter from a greater distance and consequently, in increased hours per animal darted. Because cover is not a controllable factor, should the contraceptive program continue at PORE, hiring one full-time, dedicated biotechnician with qualifications similar to Gary's is recommended.

Observation of calving rates among animals darted in both 1999 and 2000 showed that dart retrieval after a shot does not increase the likelihood of effective contraception, i.e. unchecked darts were not more likely to have missed the target animal or discharged incompletely. In fact, unretrieved darts in 2000 were more likely to result in prevention of pregnancy than retrieved darts. The reasons for this are unclear but may be related to darting locales and ease of retrieval. It is possible that accurate and effective darting in 2000 occurred more often in heavy brush where the darter was concealed but dart retrieval was more difficult. Again, it is impossible to confirm this since data on type and amount of cover were not collected. Darting elk in suboptimal anatomical areas also did not decrease contraceptive efficiency significantly in 2000.

Missed shots and unretrieved darts accounted for at least 27 potentially "live" darts left on the elk range this year. Some of the lost darts probably discharged upon impact with the ground and most are located in remote, off-trail areas of the elk reserve. It is unlikely that the pZP inside the darts would remain

pharmacologically active for long under ambient conditions. However, the darts still constitute a risk to wildlife and visitors. In the future, all fired shots, even missed ones, should be recorded along with information on dart retrieval.

Untreated control cows were twice as likely to calve in 2001 as were cows treated with pZP in 1999 and 2000. However, the theoretical efficacy rate² of pZP in Tomales Point elk ($\geq 90\%$ as per S. Shideler, U.C. Davis, 2001) is not supported by calculated efficacy rates of 25%, 69% and 62% in 1999, 2000 and 2001, respectively. Clearly, as the difference between the calving rates of control and treated animals increases, more calves are prevented and the efficacy of treatment increases. PZP treatment was least effective in 1999 when only 44% of control cows had calves and just 1.6 calves were prevented. Conversely, pZP treatment was most effective in 2000 when an estimated 15.6 calves were prevented and the control calving rate was at a 3-year high of 58%. The discrepancies between the U.C. Davis estimated efficacy rates and the efficacy rates based on PORE data are difficult to explain. Differences in PORE and U.C. Davis estimates of the natality rates of control and treated animals are the most likely cause.

Assuming that PORE efficacy rates are based on sound measurements of calving rates, fecundity of treated animals varied widely from 1999 through 2001. There are three general parameters which ultimately determine the effective contraception of free-ranging ungulates:

1. The pharmacological potency of the drug, adjuvant and drug vehicle. Improper handling and storage of the drug will affect its potency.
2. The animals' capacity to respond to the drug. The health and response potential of each animal's immune system will determine this. In addition, optimal timing of drug administration before fertilization will ensure adequate circulating levels of antibody. Maintenance of high anti-pZP antibody levels will ensure that cows are not bred late in the season, a phenomenon recorded in pZP-treated white-tailed deer (Underwood and Verret 1998).
3. Proper administration of the drug. This includes proper functioning of the dart and injection of a full dose into vascularized tissues, ideally muscle.

Interference with any of these mechanisms could impact the contraceptive efficacy rate.

Pharmacological potency is an unlikely cause of varying efficacy since all doses during the three years were produced by the same manufacturer (Dr. Irwin K. Liu, U.C. Davis) and, with few exceptions, were only defrosted prior to administration. Nine cows were treated in 2000 with pZP that was inadvertently defrosted and subsequently refrozen. These cows showed no significant increase in 2001 calving rates over 30 cows that were treated with properly frozen pZP (z statistic, $p=0.44$; H_0 is not rejected). Year-to-year variation in the timing of the inoculations cannot explain varying natality in treated animals since all yearly darting took place during the same time periods (early June through late July or early August). However, it is possible that the peaks of yearly breeding seasons varied from year to year and that some animals were already pregnant when darted. Another possible cause of the varying calving rates in treated animals is the third mechanism, inconsistent drug administration. Although animals that were known to have been darted in suboptimal anatomical locations were no more likely to become pregnant than those darted in the thigh and gluteal regions, even shots into these optimal areas could result in incomplete

² "Effective efficacy" rate as defined by Shideler (2001):

efficacy = $100 - [100 \times \% \text{ pZP treated cows that calved} / \% \text{ untreated cows that calved}]$

administration if the injection was into relatively non-vascularized tissue. Ideally, remote injection of contraceptive darts would simulate hand injection. However, the logistics of long-range inoculation of free-ranging wildlife complicate a seemingly simple injection process. Weather, topography, animal avoidance, distance, varying visibility, use of horses and inexperienced staff all reduce reproducibility of results. The only way to definitively determine the causes of the varying program efficacy would be to control for these environmental variables with captive animal trials.

If the costs of the 2001 contraceptive program (\$16,127) are divided by successfully darted cows, a minimum of \$343 was spent per treated animal. This is slightly more than the \$308 per boosted cow estimated for 2000, even adjusting for inflation. As with all "recaptures" of free-ranging ungulates, it is expected that program costs would increase yearly because of the increasing difficulty of approaching experienced targets. If minimum 2000 program costs (\$12,924) are divided by estimated 2001 calves prevented (13.3), a minimum of \$971.73 was spent for each prevented calf.

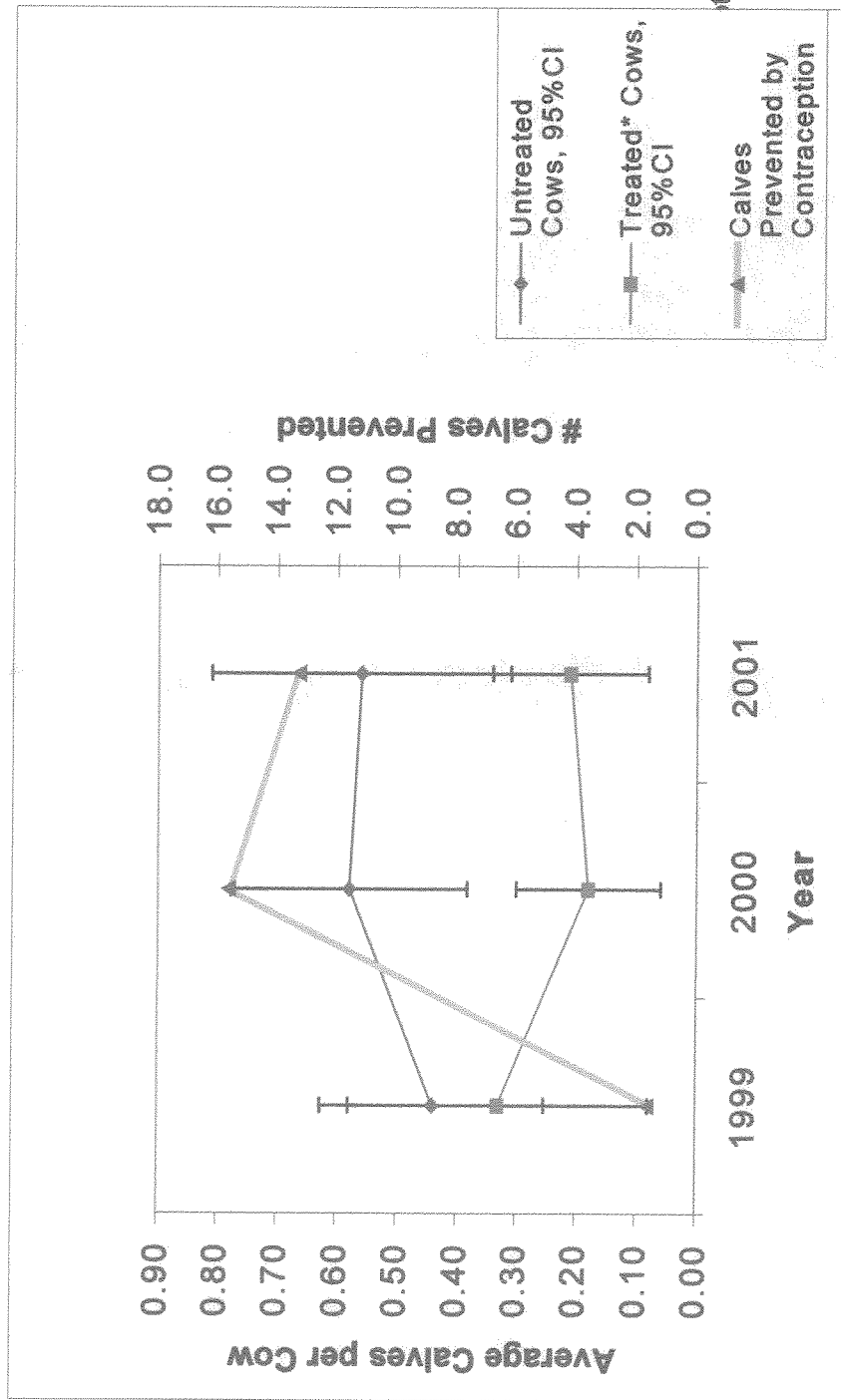
It is clear from the yearly variation in efficacy of contraceptive treatment of Tomales Point cows that the PORE boosting program should be carefully monitored and reviewed every year. Fall elk numbers at Tomales Point appear to be stable or decreasing slightly for the third consecutive year (Gates 2001). 1999-2001 calving rates for control animals, as estimated from PORE observations, are lower than the 1996-1998 average recorded by Howell (0.69 calves/cow/year) (Howell et al 2000). A high precipitation 2001-2002 winter could reduce the effects of density dependent factors on the herd and result in increased cow fecundity and calf survival in 2002. The biological parameters of herd population growth and measured elk effects on the ecosystem should be evaluated along with program costs, safety and the projected population effects of the contraception regimen at Tomales Point.

Table 2: Calving Rates for Treated* and Control Cows, Tomales Point 1999-2001 Calving Seasons

Year	CONTROL				TREATED*				Likely # calves prevented with contraception
	# calved	Total # cows	Average calves per cow	± 95% CI	# calved	Total # cows	Average calves per cow	± 95% CI	
1999	12	27	0.44	0.19	5	15	0.33	0.25	1.6
2000	11	24	0.58	0.20	7	39	0.18	0.12	15.6
2001	9	16	0.56	0.25	8	38	0.21	0.13	13.3

* = Treated with pZP for 2 consecutive years previous to that calving season.

Figure 1: Calving Rates for Treated* and Control Tomales Point Cows and Estimated Calves Prevented 1999-2001



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Appendix 1: Contraceptive Boosting Protocol
Tomaes Point, 2000
Maura Fallon-McKnight

Daily Preparation

Darting personnel will be responsible for daily preparations each morning before darting operations begin. This means gathering all the gear, drugs, and guns that will be used that day.

Daily Checklist:

Guns, magazines, charges, darts, pZP and adjuvant, needles, syringes, chapstick with Furacin® powder, rangefinders, binoculars, King radios, revised target list, armbands ("wrist coaches"), data sheets, ice packs, cooler, practice target.

Note: yellow darts are pneumatic darts for the Dan-inject pistol. Orange darts are charge darts for the Pneu Dart rifle.

Target Lists

Each day an updated target list of animals to be boosted should be placed in the armbands for the darter and horse riders to use. The target list should include: animal collar colors, frequency, A/B day, and eartag numbers. After an animal is darted in the field, they should be immediately crossed off the list.

Dart guns

Pneu Dart rifles

There are two Pneu Dart rifles in the basement of the Resource Management building. Both practice and real darts for these rifles are orange and have a "C" on the side. Power charges used in the rifles are color coded to identify the strength of the charge. Use green charges for darting elk, with the rifle set on # 3. Rifles can be accurately fired at distances from 20-50 meters.

Dan Inject pistol

There is one Dan Inject pistol in the basement of the RM building. Pneu Dart brand practice darts for the pistol are orange with a "P" on the side and the real Pneu Dart brand darts are yellow. In order to use Pneu Dart brand darts with the Dan Inject pistol, the 13-mm. barrel must be used. The 11-mm. barrel will only fire Dan Inject reusable darts, which have proven unreliable with pZP. The pistol uses CO2 cartridges and the pressurized air can be altered for each shot. For distances of roughly 30 meters, the pressure dial should read 6. The Dan Inject pistol can only be accurately fired at distances of less than 30 meters. It may be fired from horseback on certain horses that will tolerate it. The rifles may not be fired from horseback.

The darter can take practice shots the morning of the darting at the horse ranch, or at Upper Pierce Ranch at Tomales Point (if a safe location is identified). Guns should be sighted in correctly and kept clean at all times. Cleaning supplies are in the basement of the Resource Management building.

Gun safety

Guns should be unloaded, safety on, and carried inside a carrying case at all times while in a vehicle. Gun should be unloaded with safety on when on horseback and while hiking long distances. Darts can be loaded just before approaching a target group of animals. Be aware of horses and other team members while in the field. Do not point the muzzle of the gun in their direction. Never take shots in the direction of Tomales Point Trail unless you have secured the area. It is possible to have horse handlers close off portions of the trail and hold hikers back while taking a shot near the trail. Be sure that there is a good backstop for each shot.

Composition of darting teams

Each team should consist of a minimum of two people and one horse*. The darter can be on foot and one person should be riding. If teams will be working at the north end of Tomales point, it is sometimes useful to have 3-person teams. In this case, all 3 members (1 shooter and two horse handlers) will ride all the way to the north end. The extra horse person is responsible for holding their own horse and that of the shooter while the actual darting is taking place. It is best to have this handler hold the horses out of sight of the target group of elk. It sometimes makes the elk jumpy to have a team approaching them with horses moving around in the distance.

It is ideal to have two darting teams working at Tomales Point each day. One team can work in the north end, and the other team can stay in the south. The two teams should try to work as far away from each other as possible, and maintain radio contact throughout the day.

Toward the end of the darting season it will become more difficult to find target animals. During this period it is helpful to have 3-person teams with a horse – holder (even in the south end), so that the teams can cover more ground each day.

Drug Storage

The pZP will be delivered frozen in single dose vials. All vials should remain frozen until use. The adjuvant must remain refrigerated until use. Blue ice packs should be used in the field to keep both the pZP and adjuvant cold during the day. Another option is to keep pZP doses on dry ice in the field and then if you do not

* 2001 darting teams consisted of one rider and one horse in addition to the darting biotechnician. N.B. Gates.

use doses they remain frozen the entire time. The closest source of dry ice is in San Rafael.

Doses of pZP that are defrosted while in the field, but not used, should be placed in the refrigerator at the end of the day. Please mark these defrosted vials with permanent pen so they will be used first the next day. These refrigerated doses should be used within 3 or 4 days of defrosting and should not be refrozen.

Drug Preparation

The number of pZP doses you bring in the field depends on the number of teams working each day. It is recommended that each team bring out four doses a day during the beginning of the darting. You will dart more animals per day in the beginning because targets are easier to find and the animals are less wary of the teams.

You can mix up one dart in the morning once you arrive at Tomales Point, and then mix up additional darts as you need them throughout the day. Do not mix up all doses in the morning because you may not use them all. Once the pZP has been mixed with the adjuvant, and loaded into the dart, it must be used that day or discarded. An unfired dart contains a charge and should be fired at a practice target or safe backstop.

To mix up a dart: Defrost the dose of pZP by warming it in your hand. Next, draw up .5 cc Adjuvant into the glass syringe and draw up the dose of pZP into the same syringe. Remove the needle from the syringe, and attach the syringe to another glass syringe with the plastic connector. Push the pZP mixture back and forth through both syringes about 100 times (varies with ambient temperature), or until the mixture has the consistency of butter cream frosting. Push all the mixture into one syringe and remove the empty syringe with the connector on it. Put the same needle back on the syringe and insert needle all the way into the empty dart (point away from you). Slowly push mixture into dart. Put a plug of chapstick (with Furacin® powder mixed in it) on the tip of the dart to keep the drug from leaking out.* Always carry loaded darts in a secure container (point side up). The plastic package darts come in is perfect for carrying darts in the field.

You may make enough mixture for two darts at once by pulling up 1 cc of adjuvant and 2 doses of pZP.

You must bring the drugs, darts, and drug mixing syringes (in a protective case) along with you in the horse saddlebags, so you can mix darts in the field.

Identifying target elk

Many of the Tomales Point female elk have radio collars around their necks. These collars have color codes on each side. Each collar I.D. consists of three colors (a combination of white, blue, green, red, yellow and orange). The same color pattern is on each side of the collar. Collars are read from top down (from the antenna to the battery box). For example, GWR is green, white, red. Many of the collars are old and faded, and some color patches have fallen off. It takes some practice to be able to read them.

* Dart needles were not plugged in 2001, with not apparent deleterious results. N.B. Gates

All of the target animals for boosting have orange on their collars (with the exception WYY). Unfortunately, orange fades quickly, so many orange patches appear pink or whitish. For difficult collars, the darter may attempt to read the eartags of an animal for confirmation. Some animals have no eartags, so the darter will have to make a call as to whether or not the animal should be shot. Radio telemetry can also be used to identify an animal if her collar is "on" that day.

Finding target animals

At the beginning of the darting season, it is possible to ride up to groups of elk and read all the collars in the group with binoculars. You will find most of your targets in this manner. Later, when there are fewer targets left, it is necessary to use the radio receiver and antenna to locate target animals.

Darting target animals

When you have found a target, you should load the gun with a dart and be sure you have a power charge loaded. Keep the gun safety on until right before you shoot. At this point the shooter should hide behind the horse's rump and begin "stalking" the animal. The horse and shooter need to approach very slowly in order not to spook the elk. It is best if the horse is relaxed and grazing during the approach – this relaxes the elk. The shooter should try to approach within 35 meters of the target animal, although shots can be taken from further away (up to 45m.). Shots from long distances are less likely to be accurate. The rider should have a rangefinder, and can tell the shooter when the target is within range. The shooter can also wear a rangefinder so she/he can judge the shooting distance if the horse leaves her/him in a bush for a "surprise" shot.

When the shooter is within range, he/she should notify the rider when ready to take a shot. If the horse is not spooked by the noise of the rifle (Rhed), you can take shots from just behind or just in front of the horse. With horses that are more afraid of the gun (Huck), the shooter gets in position and allows the horse to walk away about five or ten meters before taking the shot. In this case, it is best to give the horse a carrot as a reward after each shot. If the shooter is the one who gives the horse a carrot, it makes the horse less afraid of the gun.

The shooter and rider should both try to watch the dart hit the animal, and determine where the animal was hit. In addition, the shooter should either take a compass bearing in the direction of the shot (after the shot), or at least put a hat or other marker down pointing in the general direction of the shot.

All fired darts should be retrieved, if at all possible. If you determined the range before you fired, and took a compass bearing, it will assist you in finding the dart. While looking for the dart, place a colored flag in the spot where the shot was taken, so you don't forget where it was. Sometimes the person on horseback can spot the darts easier than the darter on foot. If there is more than one target in a group, and you want to take another shot before finding the last dart, mark the shooting spot with a flag and record the range and compass bearing of the shot. You can find this dart later. It is recommended

that every effort be made to retrieve darts. A good rule of thumb is to spend at least one hour per dart searching in a grid pattern.

To check whether or not a dart actually discharged, insert a narrow blade of dry grass into the needle (point it away from you). If the grass only goes as deep as the needle hub, the dart is discharged. If the grass goes further than the length of the needle, into the orange part of the dart, then it didn't fire. You will see a lot of pZP on the blade of grass if it didn't discharge. Do not reuse fired darts – even if they didn't discharge. These darts must be fired at a Styrofoam target later before they are disposed of. Do not dispose of “hot” darts that did not discharge.

NOTE: If there is wind in the area, try to shoot with the wind at your back so the dart travels in a straight line.

NOTE: shooting uphill/downhill on steep slopes or in windy conditions is not recommended – the darts do not travel well in these situations.

Recording data

The darter should keep accurate records while in the field. The following information should be recorded for each darted animal: date, darter initials, rider initials, animal collar color, site of injection, distance of shot, was dart retrieved?, full or partial dose, location of elk, was a calf seen with the elk (nursing or grooming)? It is easiest to record this data in a small notebook then transfer it to a data sheet at the end of the day. A sketch of where the dart hit the body of the elk is very useful on the data sheet.

Radio Procedures

During darting operations it is important to stay in contact with members of your team, and other teams. If you are within sight of the person you would like to contact, use channel 4 (special use). This is a secure channel so other park personnel will not hear your transmission. If you cannot make contact using channel 4, then try channel 2 (Lighthouse), or channel 3 (Barnaby). Channels 2 and 3 are park-wide channels that everyone can listen to. Make these transmissions brief and use proper radio language.

End of day duties

After making sure the horses are clean and put away, the darter will be responsible for cleaning the drug mixing equipment. Needles will be disposed of (in sharps container) and replaced with new ones for the next day. Syringes should be rinsed out with hot water and then finally with rubbing alcohol. Once dry, syringes, needles and chapstick should be placed back into the cardboard tube.

Fired darts should be disposed of in the sharps container only if they were discharged.

Dart rifles should be cleaned (if needed) and stored in a secure gun locker.

Unused pZP should be refrigerated for use the next day (mark these doses so they will be used first the next day).

Adjuvant should be placed in the refrigerator.

Horse use

The darter will be responsible for organizing horse use for the days they are going out. If the darter is going to ride, she/he must prepare a horse in the morning and help clean the horses and trailer at the end of the day. Park employees must wear helmets while riding. Harold Geritz will make decisions about which horses will be used, and how they should be used. All riders must defer to Harold regarding how the horses should be handled.

Radio harnesses, saddlebags, and helmets are stored up at the horse ranch. This equipment will be used each day during the darting. Drugs, drug mixing equipment, and flags, should be carried in the saddlebag of the horse that will actually be approaching the elk. This way, the darter can reload a dart while they are in close proximity to the elk, if the need arises.

Informing the public

A sign has been created to post at the trailhead of the Tomales Point Trail, notifying hikers of the contraceptive boosting program. Be sure this sign is posted at the beginning of the season. You might want to notify 799 (dispatch) about which days of the week boosting will occur.

Hikers often stop you on the trail and ask about the project. Please take the time to answer all questions from the public. This is a great opportunity to educate park visitors.