



# Platte River Whooping Crane

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5 June 2009

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To: Whom it May Concern:

From: Felipe Chavez-Ramirez and Platte River Whooping Crane Maintenance Staff

Following are some comments and concerns regarding the Sages Final Report "Linking Freshwater Inflows and Marsh Community Dynamics in San Antonio Bay to Whooping Cranes". The comments are only based on the material that begins on page 1. The specific projects in the appendix were considered in relation to the report but will not be commented on here individually as most of them have been synthesized so much it is difficult to evaluate all the details of most of those studies.

P. 9-10

The model does not include any factors that could also affect the abundance and availability of food resources, such as competitors. The salt marshes in Aransas support many wading birds and other animals that eat crabs, for example. The second model does not include demographic aspects although there was a project designed to look at this aspect and incorporated into the overall model. Energetic budgets, had they been developed, could have been related to survival and potential reproduction of the species. The conceptual model is not 100% consistent with mathematical models presented later on.

P. 11

Considering the title and objectives outlined in this report, it seems that Table 2.2 that present summaries of empirical studies, should have a column similar to "Findings in a nutshell" perhaps named "links or relevance to whooping cranes". Some of the findings in a nutshell (water quality, hydrological connectivity, nutrient levels etc), are never incorporated into the model or considered in any way in this report.

Regarding the summary table of projects it is not clear why complementary projects were included or what the importance of them is. Some do not appear to be related to the overall model or specific objectives of the report.

P. 22.

Stated Objectives of the report are:

1. Quantify patterns of habitat use by whooping cranes in relation to changes in human-induced disturbances at ANWR,
2. Evaluate relationships among water temperature, water salinity, water depth, other physical factors, and blue crab abundance in salt-marsh habitats of ANWR,
3. Determine changes in whooping crane foraging behavior and capture rates in

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relation to abundance of blue crab and wolfberry fruit,

4. Quantify macrophytic responses in saltwater marshes to intra- and inter-annual variability in freshwater inflows, salinity, and inundation,
5. Develop a simulation model relating freshwater inflows feeding San Antonio Bay to wolfberry fruit abundance and the availability of blue crabs to whooping cranes in saltwater marshes of ANWR.

Page | 2

Objective 1. There is no presentation of habitat use patterns anywhere in the report. While it may have been done as part of one of the studies it does not seem to be treated anywhere in the document. The information presented in regards to habitat use deals more with behavior changes than changes in habitat use patterns.

Objective 2 appears to be missing wolfberries in addition to crabs, as an item of study.

Objective 3 is not actually accomplished as written. Whooping crane foraging is not explicitly related to abundance of blue crabs or wolf berry per se in this report. It appears that differences in crab abundances between years, is what is considered to fulfill this objective.

It is not clear how objective 4 is included in the simulation model.

Objective 5 would be more accurate if it said “abundance” rather than “availability” of blue crabs. Availability was never actually measured or presented anywhere in this report.

P. 26.

Figure 3.1 is not identical to figure 2.1 as stated in the legend of figure 3.1.

P. 28.

From report: “Based on ecologically-interpretable empirical relationships among the regional environmental factors and the salt marsh components, we parameterized a simulation model that predicts whooping crane energy balance as a function of the interaction of freshwater inflows, bay water level and wind (Figure 3.3).”

Comment:

The model as presented does not really estimate energy balance, as energy expenditure versus input is not considered explicitly, rather an estimate of the abundance and energy content of food resource items in the theoretical territories is what is really estimated by the model presented.

P. 29

Figure 3.3 suggests that wind influences wolfberry, but wind is not considered in the model for wolfberries, only the one for blue crabs.

P. 30 and 31

Despite discussions regarding factors that influence salinities, the equation presented only includes freshwater inflows. On the marsh itself, some factors that may be very important for affecting salinity

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levels at that scale are not considered at all, such as precipitation and evaporation. These factors, it is likely, would have less influence on salinity levels at the bay wide scale which is where the salinity values used in the model are obtained from. It is not clear why bay salinity is the variable used in this model instead of salinities within the actual whooping crane territories? We know through empirical observations that salinities can be very different in crane marshes versus those in bays during the same time period.

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P. 33

In Equation 3a for blue crabs, temperature is ignored. Apparently this is because temperature data could not be fitted to the large crabs (according to appendix data). In addition these equations are based on small crabs which are reported elsewhere (in appendix) as not being whooping crane food items. The best model on page 117 includes water temperature.

If small crabs are going to be the basis of the model on the assumption that they will grow to a size suitable for cranes at a rate of 14 mm per month, then this variable should be included in the equation to account for growth. It is not, however, even though that is the assumption explained in the text. It would be more realistic to include estimates of crab abundance and availability based on size actually taken by whooping cranes.

The equations also do not appear to account for monthly differences in density or energy of crabs even though the empirical data presented elsewhere in the report shows that it fluctuates up and down over the winter period. Perhaps it was considered, but the report does not represent any of this in an explicit way.

P. 37

The wolfberry equation does not include factors (e.g., precipitation, temperature, wind, inundation regime, soil porewater salinity), that later on are mentioned as important variables for wolfberry. For example, on p. 38, a series of factors are considered to affect wolfberry however, none of these variables are included in the equation regarding wolfberry production.

P. 40

The legend of Figure 3.7 explains that increases in wolfberry densities were due to increases in number of wolfberry plants present (not sure where this data is as the empirical study in appendix does not report density of plants). If this is true, then there must be an upper limit of how many wolfberries you can have per meter square which should be based on the number of plants present in that meter square. It is not clear that plant density was considered in the model as only berries per meter square are presented. It is also not clear whether berries per meter square is all berries or only red ripe berries. Whooping cranes do not regularly consume the green berries.

The above information, in addition to that information on pages 48 onward, shows that in two of the territories wolfberry is not really abundant. Table 3.3A shows that in some years the peak wolfberry abundance is 0.87 berries/m square. I cannot imagine how a crane can get enough to eat in a territory that has 0.87 berries per meter square if they are consuming 100% wolfberries during those peaks as suggested by one of the empirical studies. Some of the material in the appendices reports that whooping crane feed almost exclusively on wolfberries 100% of one month of one year (after peak). If we use the approx 5 berries captured per minute reported in the appendix, and 65% of time spent foraging (39 minutes/hr), as reported in another section of the report, that comes to 195 berries per hour. The crane will need to forage 9.2 hours to fulfill its 465 kcal (which is based on 5 kg captive bird and should actually be more like 7 kg

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based on wild bird weights) required by the model. However, if the peak density is 0.87 berries per meter square there is no more than one wolfberry every 10 m (0.87 berries/m square). Which means the cranes will have to travel at least 1,950 meters every hour for the 9 hours which totals 17,550 mts. It is unreasonable to assume that a crane travels 17,550 m in a day. This is not what has been observed in the field. So with minimum peak densities ranging from 0.01-0.87 (Tables 3.5A and B) it is inconceivable and unrealistic that the crane can act in a way the model expects it to do so to acquire enough energy in those years when peak wolfberry densities are so low. There are even lower values for wolfberry density (0.01, 0.06, 0.23, etc.) presented in tables. Obviously, regardless of potential disagreements as to how much a crane can move in one day while foraging, the only way to know if a real whooping crane is spending 100% of its foraging time on wolfberries during a day is to use the habitat use patterns data which is one of the stated objectives of this project. However, there is no habitat use pattern information presented anywhere despite being an objective of this study. Field observations that were conducted could also provide information on how much distance is covered by a real whooping crane in the field which would help check how realistic or unrealistic the model assumptions are. Considering that salinities were not allowed to go above 30ppt and the model still estimated very low wolfberry densities at some points, it is possible there would be even less wolfberries if the salinities were allowed to have been estimated above 30ppt in marsh territories.

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P. 39

I am not sure how the salinity levels at GBRA1 can be considered as similar or reflective of crane marsh areas (territories). It is a good measure of what is happening in the bay itself but we do not remember ever having seen salinities higher than 35ppt in the bays relative to the marsh where salinities can exceed 35ppt on a regular basis. In addition, salinities vary in different ponds in the marsh, so it's unreasonable to assume that salinity in the bay is equal and homogeneous in the marsh itself.

P.42.

section 3.2.3

From report: "We selected a model (Eq. 3) that predicted crab density relatively well at the ecosystem level (Pearson product-moment correlation factor,  $r_{ave} = 0.792$ ) for small crabs (11 to 30mm carapace width). Although this size class is slightly smaller than what whooping cranes eat, given the rapid growth of crabs (14 mm/month [Adkins, 1972]), we assumed that it provided a good estimate of recruitment into the size classes consumed by cranes."

Comments

The above statement makes some significant and unrealistic assumptions and ignores some important points:

- Abundance (or density) of prey is not equal to availability for most species in complex environments. Abundance is what is present, while availability is what the animal has access to which is rarely 100%.
- A large proportion of small blue crabs can be removed before they grow by many other species (wading birds, fish, raccoons, hogs, etc.) present in the salt marsh, so it is unrealistic to assume that all small crabs become crabs of the size cranes would eat.

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- Blue crabs could be buried due to low temperatures, making them less available which is ignored in the model equation.
- There is no measure of variability in the information presented, abundance is reported per year versus by day, week, or month, (although some tables refer to days of energy deficit)
- Crabs less than 30mm were not observed to be eaten by whooping cranes in the empirical studies presented in this report (and many other observations), yet that size class is the basis to assume cranes have more than enough to eat. If recruitment was as high as assumed in the statement above, then all the crabs that were trapped would not be less than 30 mm in size all winter long.
- 
- The equation does not include temperature even though it is widely recognized that temperature is highly influential on crab growth. If the assumption is that the small crabs will grow to the size eaten by cranes, then temperature effects on growth should be considered rather than assuming equal growth all winter regardless of temperature. You would also have to consider what proportion of the estimated crabs that are 11-30 mm reach the size classes suitable for cranes.

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From the report: “Crabs may be influenced by water level for several reasons, which led us to assume that more crabs would usually be found in deep water rather than in shallow water. Crabs may select deeper water to avoid predation from foraging wading birds or other terrestrial or aerial predators...”

## Comment

It is not clear what “deep water rather than shallow water” means here. The statement is likely to be true for crab abundance. However, beyond a certain depth blue crabs will no longer be available because cranes can either not see them or reach them. So even if we assume that deeper water has more crabs it does not mean they are available for cranes. Cranes may avoid depths greater than 80 cm to 1 m. While it is recognized that higher water level may limit predation by birds and other non-aquatic organisms, the issue that is ignored is that higher water levels may increase predation by aquatic organisms (fish, larger crabs, etc.). There is also a discussion regarding the effects of higher water buffering the effects of high or low temperatures, despite the fact that temperature is not even a variable in the equation. If the statements in the report are true, then what is the actual effect on temperature of higher water levels, what are those temperature differences, and what is the effect of temperature on variables estimated or assumed here such as crab density, crab growth and crane foraging activity.

P. 43.

From the report: “We assumed that wind speed was a proxy for water turbidity. Our original assumption was that increasing mechanisms for turbulence (e.g., wind) would increase water turbidity and subsequently increase concealment (or survival) of blue crabs in the water column (see Minello et al. 1987). In Eq. 3, crab density decreased with increasing turbidity. This indicates that crabs may be more dependent on other variables regulating

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concealment or predation risk. For instance, they may be more tied to pond edges, soft bottom substrate, high structural complexity in the water column, and/or shallow water depths than we originally assumed.”

## Comment

Concealment of blue crabs because of turbidity may change visual detection by cranes or other birds, as noted, and therefore availability. Water turbidity alone should not change actual crab density (which is what is reported in model results). However, it could change availability, but availability is not a factor actually estimated in this model despite references to potential crab concealment under variable conditions of wind, etc. The assumption, that crab density changes with turbidity is unrealistic, rather what changes with decreased visibility is the possibility of being eaten by a visual predator such as the whooping crane. However, changes in availability or predation risk are not included in the model.

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## P. 45.

From the report “We calculated an index of whooping crane energy balance within each territory (i) at time t ( $E_{Bi,t}$ ) based on our estimates of numbers of wolfberries and blue crabs ( $TW_{Bi,t}$  and  $TBC_{i,t}$ ). We calculated the metabolizable energy (kcal) contained in  $TW_{Bi,t}$  ( $METW_{Bi,t}$ ) and  $TBC_{i,t}$  ( $METBC_{i,t}$ ) as:  $METW_{Bi,t} = TW_{Bi,t} * wt_{WB} * GE_{WB} * MEC_{WB}$  (4)  $METBC_{i,t} = TBC_{i,t} * wt_{BC} * GE_{BC} * MEC_{BC}$  (5) where  $wt_{WB}$  and  $wt_{BC}$  represent the weight of wolfberries (0.44 g each, Chavez-Ramirez 1996) and blue crabs (between 11 and 30 mm carapace width, 0.939 g each, Greer, in progress), and  $GE_{WB}$  and  $GE_{BC}$  represent the gross energy content of wolfberries (1.214 kcal / g) and blue crabs (0.785 kcal / g), and  $MET_{WB}$  and  $MET_{BC}$  represent the metabolizable energy coefficient of wolfberries (0.438) and blue crabs (0.355), all as reported by Nelson et al. (1996). We then calculated  $E_{Bi,t}$  as:  $E_{Bi,t} = (METW_{Bi,t} + METBC_{i,t}) / (DER * N_{Ci,t})$  (6) where  $DER$  represents the daily energy requirement of a free-living 5 kg whooping crane (465 kcal, Nelson et al., 1996) and  $N_{Ci,t}$  represents the number of cranes occupying territory i at time t. Thus,  $E_{Bi,t} > 1.0$  indicates a positive energy balance and  $E_{Bi,t} < 1.0$  a negative energy balance for the cranes in territory i at time t.”

## Comment

There are several flawed assumptions in the above statement as described below.

This energetic model is based on daily energy requirement of cranes, it is not considering actual energy intake. Therefore, what is estimated in this model cannot be called energy balance. This model assumes that cranes automatically consume all they need every day. Assuming equal energy requirements everyday is a flawed assumption. Also basing the static daily energy requirements is likely underestimated as it is based on the weight of birds in captivity and wild birds have been recorded up to 2 kg heavier than the 5 kg used for the estimates here.

As mentioned above, food abundance is not equal to availability, therefore it should not be assumed that all cranes get their fill every day automatically just because it was estimated that there was enough food in the environment. Food consumption was estimated in a part of this project but that information is not used to determine actual food intake rates. It would have been much more realistic to have used actual food intake and energy intake rather than just assume that energy requirements are met 100% of the time if the abundance is present somewhere in the territory. When you consider that cranes in general do not visit every square meter of their territory every single day it is illogical to assume that because there is enough energy in the territory for a crane to fulfill its daily needs it actually does. Most cranes only use a portion

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of their territory during any particular day. Since some of the empirical studies were supposed to have looked at movements throughout their territories, why was this data not used to look at the proportion of territory used by the cranes per day? The food in the portion of territory used during a day would then be the potential energy available to the crane not the food in the entire territory as the model assumes. It appears that no crane activity patterns were considered despite having observed cranes. Determining how much a crane moved in one day (the distance travelled in different habitats would dictate how much area of marsh and open water it was exposed to) would give us a better idea of how much actual food they could potentially access in their foraging activities during a day. It is unrealistic to assume that 100% of food in a territory is available to the cranes every single day, especially when there appears to be no depletion rates considered at any point in time in the model.

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The weight of whooping cranes used here of 5kg is based on the one used by Nelson which is for captive whooping cranes. The weight for wild birds is known to be better represented at 7kg. Wild adult whooping cranes (unknown sex) have been weighed at 7.14 – 7.85 kg during the fall in Minnesota (Roberts 1932). Estimates of energy requirements would be greater using a bird that was 2 kg heavier than that used in the model here.

P. 45

From the report: “Our primary concern was that we neither overestimate abundance of crane food resources (specifically, wolfberries and blue crabs) nor underestimate crane energy requirements at the territory level.”

Comment

It is very likely, based on the different comments in this write-up, that food was overestimated and energy requirements of cranes underestimated.

Based on the use of small crabs size classes, and not having included variations by month, there is very likely a considerable overestimation of abundance for blue crabs. But even considering that estimates are realistic for the territory it does not mean that the crane has access to every single resource in its territory every day, as discussed above.

P. 46.

From the report “Salinities predicted at high and moderate inflow rates were similar to salinities observed at the GBRA 1 gauge (Figure 3.9), but salinities predicted at low inflow rates (28-day cumulative discharges  $< 2 \times 10^7 \text{m}^3/\text{day}$ ), were unrealistically high ( $>40$  ppt). Thus, we put an upper bound on the predictions of Eq. 1 such that predicted salinities did not exceed 30 ppt, which is 1 ppt higher than the maximum salinity observed at GBRA 1 from 2003 to 2007.”

Comment

Salinities on the Aransas marshes can at many times exceed 30 ppt. This is not rare, so it is not clear why salinities in the model were truncated at 30 ppt, especially when the effects of salinities are supposed to influence crab and wolfberry factors in the marsh. By limiting the model to 30 ppt some potential negative impacts of high salinities are therefore not included in the model. For example, high salinities were shown by one of the studies in this report (appendix) to affect wolfberry growth (p.37-38 and 98-99 of report). During winter of 2008-2009, many wolfberry plants were observed dead in some areas which was likely due to the fact that they were inundated for extended periods of time with high salinities. In addition, high

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salinities have other energetically demanding actions on whooping cranes. At salinities above 23 parts per thousand, the cranes must leave the marsh to drink freshwater at upland water sources. This means cranes must fly there, which is an energetically expensive activity. Since the model is assuming the same energy needs every day and limits the higher end of salinities, it ignores energy demands at higher salinity levels present in the marsh. A crane that needs to fly everyday to drink freshwater will have greater energy expenditure than one that does not fly at all during a day.

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P. 49

It is not clear what peak number of berries/meter square per year is. By peak, one would assume number of berries in October, however, the legend of Figure 3.10 says peak number of berries/meter square per year and there is a single bar for each year. Does this mean that during the time cranes are there, there will be X number of wolfberries every day, or is it during the peak date in October and therefore less wolfberries before and after that peak, or is it total wolfberries regardless of phenology during the fruiting season. It is difficult to understand how the phenology of wolfberries would graph over the time period the whooping cranes are present based on a single peak value.

P. 50

It is not clear what time steps are here, as in wolfberry above. For example, predicted and observed crab densities are compared in a graph, however, the observed data as reported in the appendix is based on monthly sampling and the model, it appears, deals with daily variations ("days of energy shortage"). Figure 3.11 says crab abundance as total number of crabs/year. This does not make sense as the cranes are only there during the winter. Are the months when the cranes were not present also part of the total number of crabs/year? It is not clear by reading just the legend, and it is not graphed or presented in any other format than crabs/year. As it is presented, it is not clear how this relates to crab abundance over a daily (model expectations) or monthly (as empirical data is presented) time steps during the winter period.

P.68

Many of the relationships and connections described in this section (Conclusions of study), which I assume are based on the empirical studies, are not included in the model itself. For example, it says "The second major area of study was on the behavioral ecology of cranes. The main objectives here were to document food habits and time-activity budgets of cranes, while investigating the effects of environmental conditions, food abundance, and human disturbance on the crane's energy balance." Many of the results regarding this information, some of which is presented in the Appendix, are not incorporated in the model. For example, time activity budget information, food habits, and foraging information, do not appear anywhere in the model. Some of this information could help to better inform and define some of the assumptions currently in the model that do not appear to relate to reality very well.

I am not sure what responses they are talking about as no behavior data is presented.

Conclusions regarding efficiency are misleading as empirical data show food items were included that were not included in the model. So while the conclusion may be referring to empirical studies, up to this point in the report the empirical studies do not show up. They are presented as appendices.

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Summary of inconsistencies and unreasonable assumptions made in the model that make the overall results of the model unrealistic:

- Salinities measured in the bay are assumed to be equal to those in the crane territories.
- Salinity levels measured in the bay are assumed and used in the model to influence crab abundances in crane territories.
- Salinity levels measured in the bay are assumed and used in the model to influence wolfberry abundance in crane territories.
- Salinity levels are truncated at 30 ppt. Empirical data shows salinity levels in the marsh exceed 30 ppt regularly. Higher salinities also have implications for whooping crane energetics and wolfberry production.
- 
- Crab equations use small crab size class (11-30mm) in the model despite data presented in the appendix that mentions that the likelihood of cranes eating that size class of crabs is near zero.
- Growth of small crabs is assumed and therefore is the reason for using the small size class, yet there is no variable in any equation to account for crab growth.
- While growth of crabs is assumed, equation for crab abundance ignores temperature as a variable despite the well known fact that temperature, in combination with salinity, are important factors influencing crab growth.
- 
- Biomass and energy estimated in a whooping crane territory in a particular day is assumed to be 100% available to cranes instantaneously.
- There is no consideration of actual whooping crane energy expenditure, rather energy requirement is assumed to be equal every day.
- Not clear what time steps are. For example predicted and observed crab densities are compared in a graph, however the observed data is based on monthly sampling and the model is supposed to deal with daily variations ("days of energy shortage"). The figures say crab abundance as total crabs/year. This does not make sense as the cranes are only there during the winter. Are the months when the cranes were not present also part of the total number of crabs/year? It is not clear.

Considering the large number of potentially flawed assumptions, and inconsistencies of the model assumptions to reality, it would be unwise to assume that the results and conclusions presented in this report represent reality in the field with any degree of certainty. Models of this nature should be used to explore relationships among variables, not present the results of the simulations as if they indeed represent reality at any point in time. This is particularly true of this model when so many issues regarding whooping foraging, energy expenditure, and habitat use patterns are ignored in the model. For example,

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modeling the density of blue crabs and getting similar results to empirical data is one thing, but even that information has to be qualified. The model may simulate or estimate small blue crab density very well, however, if we know and the report acknowledges this, whooping cranes do not eat this size class the conclusions that there is enough food in the territories is suspect. How food abundance is extrapolated and then assumed that whooping cranes somehow magically absorbed the energy in the environment without habitat use and foraging activity patterns being considered is quite a different story. Using similar logic we could estimate fish biomass in whooping crane territories and conclude that whooping cranes have more than enough energy in their territory to fulfill their needs. However whooping cranes eat fish only rarely (just as small crabs), so my conclusions would have to be suspect and extremely unrealistic.

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