Phase II and III Data Management Processes for 2021 Desert Tortoise Data

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Executive Summary

The 2021 Desert Tortoise Monitoring databases underwent three phases of Data Management. Phase I included data collection and correction and was performed by Great Basin Institute. Phase II (Data integration and enrichment) and Phase III (Data finalization) were performed by TopoWorks under the direction of the U.S. Fish and Wildlife Service (USFWS). These three phases result in comprehensive, standardized databases to use for desert tortoise range-wide monitoring efforts.

Following describes each of the final 2021 Desert Tortoise Range Wide Monitoring databases:

Preseason Training Lines

	Kiva	GBI	Total
Training Transects	76	262	338
Training Observations	580	2492	3072

Preseason Practice Transects

	Kiva	GBI	Total
Transects	0	16	16
Waypoints	0	416	416
Observations			
Transect Live	0	7	7
Transect Carcass	0	31	31
Opportunistic Live	0	0	0
Opportunistic Carcass	0	3	3

Season Transects

	Kiva	GBI	Total
Transects	318	215	533
Waypoints	8096	5376	13472
Observations			
Transect Live	218	60	278
Transect Carcass	168	67	235
Opportunistic Live	0	11	11
Opportunistic Carcass	0	8	8

Season G0

	Kiva	GBI	Total
G0 Start Iterations	61	56	117
G0 Observations	1390	900	2290

Records violating database rules were identified during each level of QAQC, then either resolved with a correction or allowed to remain as an exception to the rule. Many violations represent errors in the database, but not all. Violations flag unusual conditions because they are potential errors. For these potential errors (violations), the paper datasheets and associated records were reviewed to see if a correction was needed. If not, the data were allowed to remain in the database as an exception to the rule. Each violation was reviewed to make the best determination possible as to whether it represented an error or an allowed exception. Some database errors found during QA/QC can be corrected, while some cannot. The following describes violations that represented database errors. It includes errors from Phase I that could not be corrected, as well as new errors discovered during Phase II and III. For violations and corrections at each level of QA/QC, see the section titled "Error report."

Errors

	Violations	Corrections	Uncorrected
Preseason Training Lines Collection Errors	23	23	0
Preseason Practice Transects Collection Errors	5	4	1
Preseason Practice Transects Processing Errors	110	110	0
Season Transects Collection Errors	91	77	14
Season Transects Equipment Errors	60	0	60
Season Transects Processing Errors	59	59	0
Season G0 Processing Errors	65	65	0

1.0 Introduction

The 2021 Desert Tortoise Monitoring Transects database underwent three phases of Data Management Processes and QA/QC. The first phase, Phase I, included data management processes as well as QA/QC checks and procedures (also called QAQC I or Contractor QA/QC). Phase I processes and QAQC were performed by the Great Basin Institute (GBI) using tools they developed for importing and QAQC. The results of Phase I were submitted to TopoWorks. TopoWorks (under the direction of the USFWS) performed the second and third phases of Data Management Processes. Phase II included data integration, standardization, and enrichment (addition and enhancement of attribute fields). Phase III included QA/QC checks, additional standardization, creation of spatial data and finalization of data products. This document describes the Phase II and Phase III Data Management and QA/QC processes performed and the finalization of the 2021 Desert Tortoise Monitoring Preseason and Season Transects database.

2.0 Phase II Data Management Processes

The following tasks were performed during Phase II data management processes.
- Verification of Phase I products
- Compilation of Phase II products
- Processing Preseason Practice Transects
- Processing Preseason Training Lines
- Processing Season Data Transects
- Processing Season G0

2.1 Verifying Phase I products

USFWS and Great Basin Institute (GBI) submitted the following products:

Preseason Products

Preseason Products submitted by GBI via Teams QAQC I channel April 15, 2021:
- Preseason Collection Database (FORMS32K_20210401_TrainingFinal.accdb)
- Preseason Correction Database (Import_QAQC_20210401_TrainingFinal.accdb)
- Preseason Practice Transect Datasheets and Training Line Datasheets (GBI/PracticeTransects_datasheets, GBI/TrainingLines_datasheets, Kiva/TrainingLines_datasheets)

Preseason Products submitted by GBI via Teams QAQC I channel June 10, 2021:
- Preseason Practice Transect Photos (Training_Photos)

Preseason datasheets and photos were reviewed and compared to conventions in the DMP.
- Practice transect datasheets followed the conventions specified in the DMP.
- Training line datasheets followed the conventions specified in the DMP.
- Preseason photos followed the conventions specified in the DMP.

Season Products

Season Products submitted by GBI via Teams QAQC I channel June 7, 2021:
- Season Collection Database (FORMS32K_20210521_TransectFinal.accdb)
- Season Correction Database (Import_QAQC_20210521_TransectFinal.accdb
- Season Transect Datasheets (Transect_Datasheets/GBI/Transects_datasheets, Transect_Datasheets/Kiva/Transects_datasheets)
- G0 Datasheets (Transect_Datasheets/GBI/G0_datasheets, Transect_Datasheets/Kiva/G0_datasheets)

Season Products submitted by GBI via Teams QAQC I channel June 10, 2021:
- Season Transect Photos (Transect_Photos)
- Season G0 Photos (Transect_Photos/G0_Photos)

Season Products submitted by USFWS via email June 4, 2021:
- Final 2021 Desert Tortoise Rangewide Monitoring Data Management Plan with updates to page 43 (one of the G0 site extents changed for Piute-Mid site)
- Kiva preseason dates (16 March - 19 March)
- Kiva season dates (6 March - 19 May)
- GBI preseason dates (16 March – 2 April)
- GBI season dates (5 April – 19 May)
- Additional materials in MS Access database:
    - TortoiseLookUp table for use with Training Lines
    - Train_Teams table describing the survey teams
    - PlannedTransects_2021_UpdatesForMonitoredStrata containing information describing monitored strata transects
    - G0_SiteInfo_21 with starting information describing G0 sites

Season datasheets and photos were reviewed and compared to conventions in the DMP.
- Transect datasheets followed the conventions specified in the DMP.
- G0 datasheets followed the conventions specified in the DMP except that Kiva did not include the observer initials. These were corrected and recorded in the errors table.

2.2 Compiling of Phase II products

Phase I Preseason data products were packaged into the following Phase II databases:
- Preseason Practice Transects with the following populated tables:

- Transects
- Waypoints
- TranCarcObs
- TranLiveObs
- OppCarcObs
- OppLiveObs
- Errors_Transects
- Preseason Training Lines with the following populated tables:
  - Train_Tran
  - Train_Obs
  - Train_Teams
  - Errors_Training

Phase I Season data products were packaged into the following Phase II databases:
- Season Transects with the following populated tables:
  - Transects
  - Waypoints
  - TranCarcObs
  - TranLiveObs
  - OppCarcObs
  - OppLiveObs
  - Errors_Transects
- Season G0 with the following populated tables:
  - G0_Start
  - G0_Obs
  - Errors_G0

All tables were checked to make sure that all fields and records were imported. Phase I Preseason Training Lines, Season Transects, and Season G0 data contained differing record counts from the collection databases due to records added and deleted during Phase I processing.

2.3 Processing Preseason Practice Transects

Preseason Practice Transects underwent the following processing:
- Modified field names and formats as specified in the DMP or to be consistent with previous years.
  - Renamed fields prefaced with 'phone_' to match their previous names prefaced with 'gps_'. Note: These fields have not been included in the final database in previous years but keeping consistent names with previous years aids Phase III. The information comes from the phone's gps, so it still represents gps data.
  - Renamed tran_live_number, tran_carc_number, opp_live_number, and opp_carc_number to 'detection_number'.
  - Renamed interrupted_tran on Waypoints to end_tran_part to aid in Phase III.
- Verified that new fields that were added during the collection phase were included in the Phase II products:
  - No new fields were added for 2021
- For all fields in all tables, removed zero-length strings, "null" and -99 values and replaced them with true Null values.
- For all fields in all tables, replaced Y and N with Yes and No, and U with Unknown.
- Removed special characters such as returns, apostrophes, etc.

- Added and populated datasheet field.
- Verified that all datasheets were submitted and named correctly.
- Processed photos as follows:
    - Downloaded photos that were exported from the online collection database along with text files containing lists of primary key values for records that had photos.
    - Compiled and organized photos into the correct folder structure
    - Using the text files that identified which records had photos, populated the appropriate fields with the correct photo name.
    - Checked to make sure each photo identified in the database was included in the final folder structure.
- Added final_easting, final_northing, final_zone, z12_easting, z12_northing, gps_grab_success fields to the obs and waypoints tables. Populated the fields as described below.
    - For points with gps coordinates collected, populated gps_grab_success = Yes, for points with manual coordinates collected, populated gps_grab_success = No.
    - For points collected in zone 11: if manual coordinates were not collected, used the gps easting and northing fields to populate final_easting and final_northing. If manual coordinates were collected, used the manual easting and northing to populate final_easting and final_northing.
    - For points collected in zone 12: if manual coordinates were not collected, used the gps easting and northing fields to populate z12_easting and z12_northing. If manual coordinates were collected, used the manual easting and northing fields to populate z12_easting and z12_northing.
        1. Verified that only records collected in zone 12 have values in the z12 fields.
        2. Verified that final_easting and final_northing fields only contain values for points collected in zone 11. (Later, during GIS processing the zone 11 coordinates for points collected in zone 12 will be populated.)
    - Verified and populated the final_zone field using the appropriate gps or manual zone.
    - Note: Preseason Transects did not have any coordinates collected in UTM Zone 12.
- Created a Teams Lookup table. Used the Teams lookup table to make sure observer names and case were standardized throughout all tables.
- Performed duplicate record checks for the following:
    - Duplicate transect numbers within the same stratum.
    - Duplicate waypoint numbers on the same transect.
    - Duplicate transect observations.
- Checked for orphan records (transects, waypoints, and observations that do not have related records in the other tables)
- Reviewed Errors table for incorrect or missing key field values.
- Since Phase II and Phase III were performed by the same organization this year, the elev_m field was populated during Phase III by extracting values from the DEM. Populating in Phase III allows the operation to be performed on final coordinate values.
- Removed the resolved errors from the Errors table, if present. Only exceptions allowed carry on to Phase III.
- Created final Phase II PracticeTransects database with the following tables:

- Errors_Transects_21
- Observers_21
- OppCarcObs_21
- OppLiveObs_21
- SiteInfo
- Teams_21
- TranCarcObs_21
- TranLiveObs_21
- Transects_21
- Waypoints_21

2.4 Processing Preseason Training Lines

Preseason Training Lines underwent the following processing:
- Modified field names and formats as specified in the DMP or to be consistent with previous years.
    - The field total_time was changed to a field formatted as 'Double'. The Phase I database had it as text.
- For all fields in all tables, removed zero-length strings, "null" and -99 values and replaced them with true Null values.
- Removed special characters such as returns, apostrophes, etc.
- Added and populated datasheet field.
- Verified that all datasheets were submitted and named correctly.
- The Preseason Training Lines database did not have photos to verify.
- The Preseason Training Lines database did not include records with coordinates to process.
- Imported the Train_Teams_21 lookup table from data provided by USFWS. Verified that the Train_Teams_21 Lookup table contained all trials and teams.
- Performed duplicate record checks for the following:
    - Duplicate tortoise_id, trial_number, training_date, team_num, training_line_color observations.
- Checked for orphan records (observations or training transects that do not have related records in the other tables)
- Reviewed Errors table for incorrect or missing key field values and updated where appropriate.
- Removed the resolved errors from the Errors table. Only exceptions allowed carry on to Phase III.
- Created final Phase II PracticeTransects database with the following tables:
    - Errors_Training_21
    - Train_Obs_21
    - Train_Tran_21
    - Train_Teams_21

2.5 Processing Season Transects

Season Transects underwent the following processing:
- Modified field names and formats as specified in the DMP or to be consistent with previous years.
    - Renamed fields prefaced with 'phone_' to match their previous names prefaced with 'gps_'. Note: These fields have not been included in the final database in previous years but keeping consistent names with previous

years will aid Phase III. The information comes from the phone's gps, so it still represents gps data.
- Renamed tran_live_number, tran_carc_number, opp_live_number, and opp_carc_number to 'detection_number'.
- Renamed interrupted_tran on Waypoints to end_tran_part to aid in Phase III.
- Verified that new fields that were added during the collection phase were included in the Phase II products:
  - No new fields were added for 2021
- For all fields in all tables, removed zero-length strings, "null" and -99 values and replaced them with true Null values.
- For all fields in all tables, replaced Y and N with Yes and No, and U with Unknown.
- Removed special characters such as returns, apostrophes, etc.
- Added and populated datasheet field.
- Verified that all datasheets were submitted and named correctly. Incorrectly named datasheets were corrected and entered into the errors table. Missing datasheets were requested from USFWS and GBI.
- Processed photos as follows:
  - Downloaded photos that were exported from the online collection database along with text files containing lists of primary key values for records that had photos.
  - Compiled and organized photos into the correct folder structure
  - Using the text files that identified which records had photos, populated the appropriate fields with the correct photo name.
  - Checked to make sure each photo identified in the database was included in the final folder structure.
  - Several photos referenced tran_num or wp_num values that were corrected during QAQC I. These were added to the errors table and corrected.
- Created a Teams Lookup table. Used the Teams lookup table to make sure observer names and case were standardized throughout all tables.
- Added final_easting, final_northing, final_zone, z12_easting, z12_northing, gps_grab_success fields to the obs and waypoints tables. Populated the fields as described below.
  - For points with gps coordinates collected, populated gps_grab_success = Yes, for points with manual coordinates collected, populated gps_grab_success = No.
  - For points collected in zone 11: if manual coordinates were not collected, used the gps easting and northing fields to populate final_easting and final_northing. If manual coordinates were collected, used the manual easting and northing to populate final_easting and final_northing.
  - For points collected in zone 12: if manual coordinates were not collected, used the gps easting and northing fields to populate z12_easting and z12_northing. If manual coordinates were collected, used the manual easting and northing fields to populate z12_easting and z12_northing.
    1. Verified that only records collected in zone 12 have values in the z12 fields.
    2. Verified that final_easting and final_northing fields only contain values for points collected in zone 11. (Later, during GIS processing the zone 11 coordinates for points collected in zone 12 will be populated.)

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- Verified and populated the final_zone field using the appropriate gps or manual zone.
- For records collected in UTM Zone 12, used ArcGIS to convert coordinates to UTM Zone 11, WGS84 and populated final_easting and final_northing fields. Verified that all records had zone 11 coordinate values in the final_easting and final_northing fields, while only records collected in zone 12 had values in the z12_easting and z12_northing fields
- Performed duplicate record checks for the following:
  - Duplicate transect numbers within the same stratum.
  - Duplicate waypoint numbers on the same transect.
  - Duplicate transect observations.
- Checked for orphan records (transects, waypoints, and observations that do not have related records in the other tables)
- Reviewed Errors table for missing key field values (table, tran_date, tran_num, stratum, team_num, prime_key, wp_obs_num)
  - There were several records with incorrect key values for stratum, tran_date, team_num, and wp_obs_num. These values were updated with the values from the matching database records or set to Null if the database record was deleted during QAQC.
- Since Phase II and Phase III were performed by the same organization this year, the elev_m field was populated during Phase III by extracting values from the DEM. Populating in Phase III allows the operation to be performed on final coordinate values.
- Removed the Phase I resolved errors from the Errors table. Only Phase I exceptions and Phase II error records carry on to Phase III.
- Created final Phase II Season Transects database with the following tables:
  - Errors_Transects_21
  - Observers_21
  - OppCarcObs_21
  - OppLiveObs_21
  - SiteInfo
  - Teams_21
  - TranCarcObs_21
  - TranLiveObs_21
  - Transects_21
  - Waypoints_21

2.6 Processing Season G0

Season G0 underwent the following processing:
- Modified field names and formats as specified in the DMP or to be consistent with previous years.
  - Renamed fields prefaced with 'phone_' to match their previous names prefaced with 'gps_'. Note: These fields have not been included in the final database in previous years, but keeping consistent names with previous years will aid Phase III. The information comes from the phone's gps, so it still represents gps data.
- For all fields in all tables, removed zero-length strings, "null" and -99 values and replaced them with true Null values.
- For all fields in all tables, replaced Y and N with Yes and No, and U with Unknown.

- Removed special characters such as returns, apostrophes, etc.
- Added and populated datasheet field.
- Verified that all datasheets were submitted and named correctly. Kiva datasheets did not include observer initials likely because there was only one Kiva observer for 2021. For consistency with other years, the initials were added to all datasheets and error records were added to the errors table. Requested missing datasheets from USFWS and GBI.
- Processed photos as follows:
  - Downloaded photos that were exported from the online collection database along with text files containing lists of primary key values for records that had photos.
  - Compiled and organized photos into the correct folder structure
  - Using the text files that identified which records had photos, populated the appropriate fields with the correct photo name.
  - Checked to make sure each photo identified in the database was included in the final folder structure.
- Added final_easting, final_northing, final_zone, z12_easting, z12_northing, gps_grab_success fields to the obs table. Populated the fields as described below.
  - For points with gps coordinates collected, populated gps_grab_success = Yes, for points with manual coordinates collected, populated gps_grab_success = No.
  - For points collected in zone 11: if manual coordinates were not collected, used the gps easting and northing fields to populate final_easting and final_northing. If manual coordinates were collected, used the manual easting and northing to populate final_easting and final_northing.
  - Verified and populated the final_zone field using the appropriate gps or manual zone.
  - Note: For G0, there were no records collected in Zone 12.
- Created a G0 Observers Lookup table. Used the Observers lookup table to make sure observer names and case were standardized throughout all tables.
- Performed duplicate record checks for the following:
  - Duplicate G0 Start records.
  - Duplicate G0 observation records.
- Checked for orphan records (start records or observations that do not have related records in the other tables)
- Reviewed Errors table for incorrect or missing key field values and updated where appropriate.
- Changed values of -99 or null to True null in the Errors table. (tort_obs_num)
- Since Phase II and Phase III were performed by the same organization this year, the elev_m field was populated during Phase III by extracting values from the DEM. Populating in Phase III allows the operation to be performed on final coordinate values.
- Removed the resolved errors from the Errors table. Only exceptions allowed carry on to Phase III.
- Created final Phase II Season G0 database with the following tables:
  - Errors_G0_21
  - G0_Obs_21
  - G0_Observers_21
  - G0_Start_21
  - SiteInfo

3.0 Phase III Data Management Processes

Phase III Data Management steps were performed on all databases:
- Preseason Practice Transects
- Preseason Training Lines
- Season Transects
- Season G0

For each database, rules were established to flag potential errors. These rules were first identified while developing the data management plan, then refined throughout the season and throughout the data management phases.

Six main types of rules were established, as described below. For the detailed rules in each category, refer to the Appendices. There is an appendix for each database.

Type of rule	Description
Relationship	identifies orphans or deviations in the expected number of features related to another feature (such as an observation without a related transect)
Domain	identifies values that are not within a specified range or set (such as mcl_mm greater than 500)
Duplicate condition	identifies duplicate records (such as duplicate transects)
SQL condition	identifies records that satisfy a specific SQL query (such as records where the observer and group in one table does not match the observer and group in another table)
Spatial conditions for related features	identifies records that do not satisfy a spatial relationship with a related feature (such as observations that are more than 50 meters away from their related transect)
Field condition	identifies records that do not meet specific conditions for field values (such as observer1 and observer2 being the same person)

Phase III Data Management was a multi-step process for each database. Steps included:
1. Reviewing Phase II products
2. Preparing the database
3. Identifying, reviewing and resolving violations
4. Finalizing and standardizing the database.

3.1 Preseason Practice Transects

3.1.1 Reviewing Phase II Practice Transects products

The Phase II databases, datasheets and photos were used as inputs for Phase III.

Verifying the Phase II Preseason Practice Transect Errors table
The Phase II Errors table was reviewed. As specified in the Data Management Plan,

- It included a table_name field and a prime_key field which identified the database table and record for which the error record was associated, as well as additional informational fields—tran_date, tran_num, stratum, team_num, and wp_obs_num—describing the database record for which each error record was associated.

- Resolved QAQCI errors and QAQCI script errors were not included.
- Phase II error descriptions matched Phase I and no duplicate error records were created during Phase II.
- Values of -99 and 'null' had been changed to true Null values.
- For Transect errors, values of 0 for wp_obs_num had been changed to true Null values because there is not a waypoint or observation number for transect errors.

Verifying the Transects scanned datasheets

The scanned datasheets were reviewed and there were no deviations found from the naming convention specified in the DMP. Missing datasheets were already identified during Phase II.

Verifying the Transects photos

The photos were reviewed and there were no deviations found from the naming convention specified in the DMP. Missing photos and corrections to file names were already identified during Phase II.

Verifying the Transects MS Access database

Record counts were compared with Collection and Phase I databases. Record counts matched.

Verified that field names and formats matched those specified in the Data Management Plan (or were consistent with previous years).

Verified that all needed tables were included in Phase II products.

3.1.2   Preparing the database

The Phase II Practice Transects database products were prepared by:

- Categorizing Error records
- Importing Phase II Error records into the final processing violation table format
- Integrating "other" values with their appropriate field
- Deleting unnecessary fields (UnitID, calculated, exported)
- Creating lookup tables
- Standardizing interrupted transect records
    - Interrupted transects are transects that require gaps while crews navigate terrain with obstacles. To capture those transects in the field database, they are represented as multiple transect records (e.g. 1378, 1378.1, and 1378.2). For the final database products, these records were combined into a single record representing the transect. In the spatial database, interrupted transects are represented by single line features with multiple parts (segments). The times were standardized for the resulting single transect so that it represented the drop off, start, end and return to drop off times for the entire transect. Some interrupted transect records also contained a mixture of values for the fields describing whether a transect was standard and if not, what obstacles were present. All of these fields were standardized so that they contained the combined descriptions and comments from all records used to collect the interrupted transect. The comments field was also standardized to combine comments from all portions of an interrupted transect. All appropriate waypoints and observations were associated with the resulting single transect.
- Miscellaneous preparations
    - Added folder name to the datasheet field so that it could more readily be used to hyperlink to the appropriate file.

- Checked to make sure scanned datasheet file existed for each transect.
- Checked to make sure photos existed for each photo field throughout the Waypoints and Observation tables.
- For non-standard transects, replaced Null values for terr_obstacles, subs_obstacles, and other_obstacles with 'None' for more clarity.
- Generated a final unique ID number that is unique within all years of Desert Tortoise Monitoring Transect data. The ID was generated by prefixing the QA/QC ID number with the year of data collection and the type. For example, transects ID was generated by concatenating "2021trn" with the QA/QC ID number.
- Standardized data values for terr_obstacles, subs_obstacles, and other_obstacles to remove extra semicolons (;;) and duplicate values.
- Added and populated fields for waypoints describing the length of the segment between the last waypoint and the current waypoint, along with the total length of the transect at that waypoint.
- Added and populated a field for each of the transect observations tables for transect length at the last waypoint.
- Rounded perpendicular distances to one decimal place.
- Checked for apostrophes in observer names (such as in past years with "Brendan O'Brien"). There were no apostrophes in observer names this year.
- Updated summary information for transects as follows: transect length, total transect live and carcass observations, total opportunistic live and carcass observations.
- Imported StrataBnd from previous year.
- Imported StrataSubunits from previous year.

3.1.3   Identifying, reviewing and resolving violations

Records not following the established rules were identified as violations Many violations represent errors in the database, but not all. Violations flag unusual conditions because they are potential errors. If a record violated more than one condition, each violation was recorded so that when the record was resolved, all violated conditions could be considered. Many times, there are several violations for one database record.

Each violation was reviewed, evaluated, and either resolved with a correction or allowed to remain in the database as an exception to the rule. Paper datasheets and associated records helped identify corrections. The database rules were checked many times to resolve all violations and catch potential errors that might be introduced while making changes to the database. Each violation was reviewed to make the best determination possible as to whether it represented an error or an allowed exception.

Violations are especially problematic when a large number of a particular type of error is found or when data cannot be corrected during QA/QC. Many of these might be addressed in the future during training for the field crews, while some may need evaluation to determine if equipment needs to be replaced or the collection Pendragon database or other processing steps can reduce those errors.

3.1.4 Preseason Practice Transects Error Report

Phase I Practice Transects Violations: The following describes violations from *Phase I* that represent errors that could not be corrected (and thus must remain in the database), as well as violations that represent exceptions to the rules, but are not errors. Violations for errors that were corrected during Phase I (the end of the collection phase) are not included.

Phase I Practice Transect Violations	
Collection errors that could not be corrected	1
Equipment errors that could not be corrected	0
Exceptions (not errors)	4
TOTAL	5

Phase II and Phase III Practice Transects Violations: The following describes violations addressed during *Phase II* and *Phase III.*

	Violations	Corrections	Uncorrected
Phase II			
Processing Errors	69	69	0
Exceptions (not errors)	0	0	0
Phase III			
Collection Errors	4	4	0
Processing Errors	41	41	0
Exceptions (not errors)	11	N/A	N/A
TOTALS	125	0	0

Following are the errors that were found along with their correction status.

Collection Errors	Violations
Corrected	
waypoint time_ is not consecutive	1
incorrect ret_do_time	1
inconsistency with lead or follow	1
comments contain special character	1
Uncorrected	
inconsistency between carc_condition and mcl_mm	1
Processing Errors	
Corrected	
incorrect photo file name	69
incorrect tran_num	41

3.1.5 Finalizing and standardizing the database

In addition to resolving violations, the database was finalized with the following steps:
- Updated summary information on the strata boundary feature class for transects walked, km walked, group, sampling start date, sampling end date, total transect live and carcass observations, and total opportunistic live and carcass observations.
- Created an ArcGIS ArcMap document and associated layer files for the spatial formats.
- Created metadata for all tables.
- Created the series of final internal user and management products.

The Preseason Practice Transects 2021 internal user products included data for transects, waypoints, observations, and strata and were provided in each of the following formats:
- ArcGIS File Geodatabase
- Stand alone Microsoft Access Database (not a geodatabase)
- Microsoft Excel

The Preseason Practice Transects 2021 management products included data for transects, waypoints, observations, strata, and violations and were provided in each of the following formats:
- ArcGIS File Geodatabase
- Stand alone Microsoft Access Database (not a geodatabase)
- Microsoft Excel

3.2 Preseason Training Lines

3.2.1   Reviewing Phase II Preseason Training Line products
The Phase II database and datasheets were used as inputs for Phase III.

Verifying the Phase II Training Lines Errors table
The Phase II Errors table was reviewed. As specified in the Data Management Plan,
- It included a table_name field and a prime_key field which identified the database table and record for which the error record was associated, as well as additional informational fields—training_date, trial_number, team_num, training_line_color, transect, and tortoise_id—describing the database record for which each error record was associated.
- Resolved QAQCI errors and QAQCI script errors were not included.
- Phase II error descriptions matched Phase I and no duplicate error records were created during Phase II.
- Values of -99 and 'null' had been changed to true Null values.
- For Training Transect errors, values of 0 for tortoise_id had been changed to true Null values because there is not a tortoise id number associated with training transect errors.

Verifying the Training Line scanned datasheets
The scanned datasheets were reviewed and there were no deviations found from the naming convention specified in the DMP. Incorrectly scanned datasheets were already identified during Phase II.

Verifying the Training Line MS Access database
Record counts were compared with Collection and Phase I databases. QAQC checks were used to validate all records.

Verified that field names and formats matched those specified in the Data Management Plan (or were consistent with previous years).

Verified that all needed tables were included in Phase II products.

3.2.2   Preparing the database

As part of Phase III data management processes, the Phase II Training Lines database was prepared by:
- Categorizing Error records

- Importing Phase II Error records into the final processing violation table format
- Deleting unnecessary fields (UnitID, calculated, exported)
- Miscellaneous preparations
    - Checked to make sure scanned datasheet file existed for each trial, team and day.
    - Generated a final unique ID number that is unique within all years of Desert Tortoise Monitoring Transect data. The ID was generated by prefixing the QA/QC ID number with the year of data collection and the type. For example, training transect ID was generated by concatenating "2021trt" with the QA/QC ID number.
    - Verified that there were no apostrophes in observer names (such as in past years with "Brendan O'Brien"). Apostrophes can cause problems with other programs. There was an apostrophe in an observer name this year. The records were changed to remove the apostrophe and recorded in the violations table. Apostrophes can cause problems with software programs.

3.2.3   Identifying, reviewing, and resolving violations

Records not following the established rules were identified as violations Many violations represent errors in the database, but not all. Violations flag unusual conditions because they are potential errors. If a record violated more than one condition, each violation was recorded so that when the record was resolved, all violated conditions could be considered. Many times, there are several violations for one database record.

Each violation was reviewed, evaluated, and either resolved with a correction or allowed to remain in the database as an exception to the rule. Paper datasheets and associated records helped identify corrections. The database rules were checked many times to resolve all violations and catch potential errors that might be introduced while making changes to the database. Each violation was reviewed to make the best determination possible as to whether it represented an error or an allowed exception.

Violations are especially problematic when a large number of a particular type of error is found or when data cannot be corrected during QA/QC. Many of these might be addressed in the future during training for the field crews, while some may need evaluation to determine if equipment needs to be replaced or the collection Pendragon database or other processing steps can reduce those errors.

3.2.4   Preseason Training Lines Error report

Phase I Training Line Violations: The following describes violations from *Phase I* that represent errors that could not be corrected (and thus must remain in the database), as well as violations that represent exceptions to the rules, but are not errors. Violations for errors that were corrected during Phase I (which represents the end of the collection phase) are not included.

Phase I Violations	
Collection errors that could not be corrected	0
Equipment errors that could not be corrected	0
Exceptions (not errors)	20
TOTAL	20

Phase II and Phase III Training Line Violations: The following describes violations addressed during *Phase II* and *Phase III.*

	Violations	Corrections	Uncorrected
Phase II			
Collection errors	0	0	0

Exceptions (not errors)	0	N/A	N/A
Phase III			
Collection errors	23	23	0
Exceptions (not errors)	3	N/A	N/A
TOTALS	26	23	0

Following are the errors that were found along with their correction status.

Collection Errors	Violations
Corrected	
tortoise_id and tortoise_size do not match TortInfo table	15
comments contain special character	6
perp_dist_m does not match calculated perp_dist_m	1
observer_name and observer_position do not match lead or follow in Train_Tran table	1

3.2.5   Finalizing and standardizing the database

In addition to resolving violations, the database was finalized with the following steps:
- Created metadata for all tables.
- Created the series of final internal user and management products.

The Preseason Training Lines 2021 internal user products included data for training transects, training observations, and teams and were provided in Microsoft Access Database format.

The Preseason Training Lines 2021 management products included data for training transects, training observations, teams, tort info, tortoise line lookup info and violations and were provided in Microsoft Access Database format.

3.3 Season Transects

3.3.1   Reviewing Phase II Season Transect products

The Phase II databases, datasheets and photos were used as inputs for Phase III.

Verifying the Phase II Transects Errors table
The Phase II Errors table was reviewed. As specified in the Data Management Plan,
- It included a table_name field and a prime_key field which identified the database table and record for which the error record was associated, as well as additional informational fields—tran_date, tran_num, stratum, team_num, and wp_obs_num—describing the database record for which each error record was associated.
- Resolved QAQCI errors and QAQCI script errors were not included, as per DMP.
- Phase II error descriptions matched Phase I and no duplicate error records were created during Phase II.
- Values of -99 and 'null' for key fields had been changed to true Null values.
- For Transect errors, values of 0 for wp_obs_num had been changed to true Null values because there is not a waypoint or observation number associated with transect errors.
- There were not any error records where values had been changed in Phase I but were marked as exceptions allowed. If a value is changed, it should be marked as resolved.

Verifying the Transects scanned datasheets

The scanned datasheets were reviewed and there were no deviations found from the naming convention specified in the DMP. Missing datasheets and corrections to file names were already identified during Phase II.

Verifying the Transects photos

The photos were reviewed and there were no deviations found from the naming convention specified in the DMP. Missing photos and corrections to file names were already identified during Phase II.

Verifying the Transects MS Access database

Record counts were compared with Collection and Phase I databases. Record counts differed slightly due to additions and deletions during Phase I processing. QAQC checks were used to validate all records.

Verified that field names and formats matched those specified in the Data Management Plan or were consistent with previous years.

Verified that all needed tables were included in Phase II products.

3.3.2   Preparing the database

As part of Phase III data management processes, the Phase II Transects database products were prepared by:
- Categorizing Error records
- Importing Phase II Error records into the final processing violation table format
- Integrating "other" values with their appropriate field
- Deleting unnecessary fields (UnitID, calculated, exported)
- Creating lookup tables
- Standardizing interrupted transect records
    - Interrupted transects are transects that require gaps while crews navigate terrain with obstacles. To capture those transects in the field database, they are represented as multiple transect records (e.g. 1378, 1378.1, and 1378.2). For the final database products, these records were combined into a single record representing the transect. In the spatial database, interrupted transects are represented by single line features with multiple parts (segments). The times were standardized for the resulting single transect so that it represented the drop off, start, end and return to drop off times for the entire transect. Some interrupted transect records also contained a mixture of values for the fields describing whether a transect was standard and if not, what obstacles were present. All of these fields were standardized so that they contained the combined descriptions and comments from all records used to collect the interrupted transect. The comments field was also standardized to combine comments from all portions of an interrupted transect. All appropriate waypoints and observations were associated with the resulting single transect.
- Miscellaneous preparations
    - Added folder name to the datasheet field so that it could more readily be used to hyperlink to the appropriate file.
    - Checked to make sure scanned datasheet file existed for each transect.
    - Checked to make sure photos existed for each photo field throughout the Waypoints and Observation tables.

- For non-standard transects, replaced Null values for terr_obstacles, subs_obstacles, and other_obstacles with 'None' for more clarity.
- Generated a final unique ID number that is unique within all years of Desert Tortoise Monitoring Transect data. The ID was generated by prefixing the QA/QC ID number with the year of data collection and the type. For example, transects ID was generated by concatenating "2021trn" with the QA/QC ID number.
- Standardized data values for terr_obstacles, subs_obstacles, and other_obstacles to remove extra semicolons (;;) and duplicate values.
- Added and populated fields for waypoints describing the length of the segment between the last waypoint and the current waypoint, along with the total length of the transect at that waypoint.
- Added and populated a field for each of the transect observations tables for transect length at the last waypoint.
- Rounded perpendicular distances to one decimal place.
- Checked for apostrophes in observer names (such as in past years with "Brendan O'Brien"). There were no apostrophes this year. Apostrophes can cause problems with software programs.
- Updated summary information for transects as follows: transect length, total transect live and carcass observations, total opportunistic live and carcass observations.
- Integrated 2021 transect tracking information (sel_21, type_21, walked_21, replaced_21, reason_replaced_21) from transect tracking information from USFWS with the master PlannedTransects_all table.
- Verified walk_desc_21 and substrat_obs_21 between walked Transects and Planned Transects
- Added and populated a field named reduction_obs_21 to describe whether the length of each transect was reduced, and if so whether the reduction was only minor or whether it was reduced in a major (significant) way.
- Reviewed comments for unusual circumstances.
- For transects walked on 3/6/2021, 3/7/2021, 3/8/2021, 3/9/2021, 3/10/2021, 3/11/2021, 3/12/2021, and 3/13/2021 changed all times to Pacific Daylight Savings by adding one hour. There may be violations recorded that reference times before these changes. This affected the following:
    - Transects: do_time, tran_start_time, tran_end_time, ret_do_time
    - Waypoints, TranLiveObs, TranCarcObs, OppLiveObs: time_
- Imported StrataBnd from previous year.
- Imported StrataSubunits from previous year.
- Updated PlannedTransects_all G0_group to match edits provided by FWS.
- For observations where new tags were attached, populated the new_tag_color field with 'White'.

3.3.3   Identifying, reviewing and resolving violations

Records not following the established rules were identified as violations Many violations represent errors in the database, but not all. Violations flag unusual conditions because they are potential errors. If a record violated more than one condition, each violation was recorded so that when the record was resolved, all violated conditions could be considered. Many times, there are several violations for one database record.

Each violation was reviewed, evaluated, and either resolved with a correction or allowed to remain in the database as an exception to the rule. Paper datasheets and associated records helped identify corrections. The database rules were checked many times to resolve all violations and catch potential errors that might be introduced while making changes to the

database. Each violation was reviewed to make the best determination possible as to whether it represented an error or an allowed exception.

Violations are especially problematic when a large number of a particular type of error is found or when data cannot be corrected during QA/QC. Many of these might be addressed in the future during training for the field crews, while some may need evaluation to determine if equipment needs to be replaced or the collection Pendragon database or other processing steps can reduce those errors.

3.3.4   Season Transects Error report

Phase I Season Transect Violations: The following describes violations from *Phase I* that represent errors that could not be corrected (and thus must remain in the database), as well as violations that represent exceptions to the rules, but are not errors. Violations for errors that were corrected during Phase I (which represents the end of the collection phase) are not included.

Phase I Violations	
Collection errors that could not be corrected	7
Equipment errors that could not be corrected	2
Exceptions (not errors)	79
TOTAL	88

Phase II and Phase III Season Transect Violations: The following describes violations addressed during *Phase II* and *Phase III.*

	Violations	Corrections	Uncorrected
Phase II			
Processing errors	47	47	0
Phase III			
Collection errors	84	77	7
Equipment errors	58	58	0
Processing errors	12	12	0
Exceptions (not errors)	179	N/A	N/A
TOTALS	380	194	7

Following are the errors that were found along with their correction status.

Collection Errors		Violations
Corrected		
	incorrect tran_num	20
	comments contain special character	16
	inconsistency with tran_standard, obstacles, or unplanned_mod	13
	inconsistency between unplanned_mod and obstacles	8
	inconsistency with last_wp	5
	waypoint is 0, 1, or 100 but burrow_ct is not null	5
	wp_num is not consecutive	2
	crew interrupted transect but lead and follow are not null	2
	incorrect file name	2
	lead or follow is null	2
	missing transect segment	2
Uncorrected		
	tran_start_time not within domain	4
	inconsistency with date	4
	do_time not within domain	1
	inconsistency between carc_condition and mcl_mm	1
	inconsistency between existing tag and new tag attached	1
	inconsistency with time	1
	inconsistency with wp time	1
	do_time is after tran_start_time	1
Equipment Errors		
Uncorrected		
	inconsistency with date	54
	inconsistency with time	4
	TimeStamp_ not within domain	2
Processing Errors		
Corrected		
	incorrect file name	38
	missing datasheet	21

3.3.5   Finalizing and standardizing the database

In addition to resolving violations, the database was finalized with the following steps:
  ▪ Updated summary information on the strata boundary feature class for transects assigned, transects walked, km walked, group, sampling start date, sampling end date, total transect live and carcass observations, and total opportunistic live and carcass observations.
  ▪ Created an ArcGIS ArcMap document and associated layer files for the spatial formats.
  ▪ Created metadata for all tables.
  ▪ Created the series of final internal user and management products.

The Season Transects 2021 internal user products included data for transects, waypoints, observations, strata, and planned transects and were provided in each of the following formats:
- ArcGIS File Geodatabase
- Stand alone Microsoft Access Database (not a geodatabase)
- Microsoft Excel

The Season Transects 2021 management products included data for transects, waypoints, observations, strata, planned transects, and violations and were provided in each of the following formats:
- ArcGIS File Geodatabase
- Stand alone Microsoft Access Database (not a geodatabase)
- Microsoft Excel

3.4 Season G0

3.4.1   Reviewing Phase II Season G0 products

The Phase II databases, datasheets and photos were used as inputs for Phase III.

Verifying the Phase II G0 Errors table
The Phase II Errors table was reviewed. As specified in the Data Management Plan,
- It included a table_name field and a prime_key field which identified the database table and record for which the error record was associated, as well as additional informational fields—G0_date, G0_site, observer, group_, and tort_obs_num—describing the database record for which each error record was associated.
- Resolved QAQCI errors and QAQCI script errors were not included.
- No duplicate error records were created during Phase II.
- Values of -99 and 'null' had been changed to true Null values.

Verifying the G0 scanned datasheets
The scanned datasheets were reviewed and there were no deviations found from the naming convention specified in the DMP. Incorrectly named datasheets or missing datasheets were already identified during Phase II.

Verifying the G0 photos
The photos were reviewed and there were no deviations found from the naming convention specified in the DMP. Incorrectly named photos were already identified during Phase II.

Verifying the G0 MS Access database
Record counts were compared with Collection and Phase I databases. Record counts matched.

Verified that field names and formats matched those specified in the Data Management Plan (or were consistent with previous years).

Verified that all needed tables were included in Phase II products.

3.4.2   Preparing the database

As part of Phase III data management processes, the Phase II G0 database products were prepared by:
- Categorizing Error records

- Importing Phase II Error records into the final processing violation table format
- Deleting unnecessary fields (UnitID, calculated, exported)
- Creating lookup tables
- Miscellaneous preparations
    - Added folder name to the datasheet field.
    - Checked to make sure scanned datasheet file existed for each G0 start record.
    - Checked to make sure photos existed for each photo field.
    - Generated a final unique ID number that is unique within all years of Desert Tortoise Monitoring Transect data. The ID was generated by prefixing the QA/QC ID number with the year of data collection and the type. For example, G0 observations ID was generated by concatenating "2021G0o" with the QA/QC ID number.
    - Verified that there were no apostrophes in observer names (such as in past years with "Brendan O'Brien"). Apostrophes can cause problems with other programs.
    - Added the final ID from the Start record to its associated observations to act as a single-field unique identifier in place of the G0_prime_key identifier created by the field units.
    - Removed the burned field from the G0_Obs table.
    - Reviewed comments for unusual circumstances.
    - For G0 iterations walked on 3/6/2021, 3/7/2021, 3/8/2021, 3/9/2021, 3/10/2021, 3/11/2021, 3/12/2021, and 3/13/2021, changed all times to Pacific Daylight Savings by adding one hour. There may be violations recorded that reference times before these changes. This affected the following:
        - G0_Start_21: start_time, end_time
        - G0_Obs_21: time_

3.4.3   Identifying, reviewing and resolving violations

Records not following the established rules were identified as violations Many violations represent errors in the database, but not all. Violations flag unusual conditions because they are potential errors. If a record violated more than one condition, each violation was recorded so that when the record was resolved, all violated conditions could be considered. Many times, there are several violations for one database record.

Each violation was reviewed, evaluated, and either resolved with a correction or allowed to remain in the database as an exception to the rule. Paper datasheets and associated records helped identify corrections. The database rules were checked many times to resolve all violations and catch potential errors that might be introduced while making changes to the database. Each violation was reviewed to make the best determination possible as to whether it represented an error or an allowed exception.

Violations are especially problematic when a large number of a particular type of error is found or when data cannot be corrected during QA/QC. Many of these might be addressed in the future during training for the field crews, while some may need evaluation to determine if equipment needs to be replaced or the collection Pendragon database or other processing steps can reduce those errors.

3.4.4   Season G0 Error report

Phase I Season G0 Violations: The following describes violations from *Phase I* that represent errors that could not be corrected (and thus must remain in the database), as well as violations that represent exceptions to the rules, but are not errors. Violations for errors that were corrected during Phase I (which represents the end of the collection phase) are not included.

Phase I Violations	
Collection errors that could not be corrected	0
Equipment errors that could not be corrected	0
Exceptions (not errors)	3
TOTAL	3

Phase II and Phase III Season G0 Violations: The following describes violations addressed during *Phase II* and *Phase III.*

	Violations	Corrections	Uncorrected
Phase II			
Processing errors	65	65	0
Phase III			
Exceptions (not errors)	4	N/A	N/A
TOTALS	69	65	0

Following are the errors that were found along with their correction status.

Processing Errors		Violations
Corrected		
	incorrect datasheet file name	62
	missing datasheet file	3

3.4.5   Finalizing and standardizing the database

In addition to resolving violations, the database was finalized with the following steps:
- Updated the G_0 Site Information table according to the following:
  - Added fields for the G_0 site description, G_0 group, and covered strata from USFWS.
  - Updated minimum and maximum easting and northing in the Site Information table to represent a 1,000 m buffer around observations.
  - Added start date and end date for iterations in each G_0 site to the Site Information table.
- Created an ArcGIS ArcMap document and associated layer files for the spatial formats.
- Created metadata for all tables.
- Created the series of final internal user and management products.

The Season G_0 2021 internal user products included data for start records, observations, and site information and were provided in each of the following formats:
- Stand alone Microsoft Access Database (not a geodatabase)
- Microsoft Excel

The Season G_0 2021 management products included data for start records, observations, site information, and violations and were provided in each of the following formats:

- ▪ ArcGIS File Geodatabase
- ▪ Stand alone Microsoft Access Database (not a geodatabase)
- ▪ Microsoft Excel

4.0 Summary

The 2021 Tortoise Monitoring collection databases contained many errors as any field database does. The QA/QC and data management processes detected and corrected many of those errors as well as standardized the database so that it can be better utilized for analysis. Error correction is important so that analysis is performed on the most accurate data possible, while standardization is important for database integrity and to help avoid confusion (and misuse) during analysis. Evaluation of the most common and significant errors can be used to improve data collection and reduce errors in future years of monitoring.

Appendix A: 2021 Preseason Practice Transects Database Final QA/QC Rules

Relationship Checks

From Table	Primary Key	To Table	Foreign Key	Cardinality Rules
Transects_21	tran_prime_key	Waypoints_21	tran_prime_key	1 to Many
Transects_21	tran_prime_key	OppCarcObs_21	tran_prime_key	1 to Many
Transects_21	tran_prime_key	TranCarcObs_21	tran_prime_key	1 to Many
Transects_21	tran_prime_key	TranLiveObs_21	tran_prime_key	1 to Many
Teams_21	team_num	Transects_21	team_num	1 to Many
Observers_21	observer	Transects_21	observer1	1 to Many
Observers_21	observer	Transects_21	observer2	1 to Many
StrataBnd_21	stratum	Transects_21	stratum	1 to Many
StrataBnd_21	stratum	Waypoints_21	stratum	1 to Many
StrataBnd_21	stratum	OppCarcObs_21	stratum	1 to Many
StrataBnd_21	stratum	TranCarcObs_21	stratum	1 to Many
StrataBnd_21	stratum	TranLiveObs_21	stratum	1 to Many

Range Domain Checks (numeric or date ranges of acceptable values)

Domain	Low value	High value	Table and fields applied to
Drop_Start_time	4:00:00 AM	10:00:00 AM	Transects_21: do_time, Transects_21: tran_start_time
End_Ret_time	8:00:00 AM	6:30:00 PM	Transects_21: tran_end_time, Transects_21: ret_do_time
Time	4:00:00 AM	6:30:00 PM	Waypoints_21: time_, TranCarcObs_21: time_, TranLiveObs_21: time_
TranNum	1	70	Transects_21: tran_num, Waypoints_21: tran_num, OppCarcObs_21: tran_num, TranCarcObs_21: tran_num, TranLiveObs_21: tran_num,
TranDate	3/30/2021	4/1/2021	Transects_21:date_, Transects_21: TimeStamp_, Waypoint_21: TimeStamp_, OppCarcObs_21: TimeStamp_, TranCarcObs_21: TimeStamp_, TranLiveObs_21: TimeStamp_
Team_num	1	27	Transects_21:team_num, Waypoints_21: team_num, OppCarcObs_21: team_num, TranCarcObs_21: team_num, TranLiveObs_21: team_num,
TranLength	6500	12500	Transects.trn_length_m
Wp_num	0	100	Waypoints_21:wp_num
BurrowCt	0	30	Waypoints_21.burrow_ct

Last_wp	1	30	TranCarcObs_21: last_wp, TranLiveObs_21: last_wp
Easting	408849	794114	Waypoints_21:easting, OppCarcObs_21:easting, TranCarcObs_21:easting, TranLiveObs_21:easting, PlannedTransects_all: sw_easting
Northing	3648506	4133135	Waypoints_21:northing, OppCarcObs_21:northing, TranCarcObs_21:northing, TranLiveObs_21:northing, PlannedTransects_all: sw_northing
Elevation	0	1800	Waypoints_21: elev_m, OppCarcObs_21: elev_m, TranCarcObs_21: elev_m, TranLiveObs_21: elev_m
Num_live_obs	0	15	TranLiveObs: detection_number Transects: num_oppliveobs, num_tranliveobs
Num_carc_obs	0	20	OppCarcObs: detection_number TranCarcObs: detection_number Transects: num_oppcarcobs, num_trancarcobs
Bearing	0	360	TranCarcObs_21: tran_bearing, local_bearing TranLiveObs_21: tran_bearing, local_bearing
Azimuth	0	360	TranCarcObs_21: azimuth, TranLiveObs_21: azimuth
Distance_to_burrow	0	100	TranLiveObs_21:dist_to_burrow,
Radial_distance	0	60	TranCarcObs_21: radial_distance_m, TranLiveObs_21: radial_distance_m
Perp_distance	0	50	TranCarcObs_21: perp_distance_m, TranLiveObs_21: perp_distance_m
Mcl_mm	1	400	OppCarcObs_21: mcl_mm, TranCarcObs_21: mcl_mm, TranLiveObs_21: mcl_mm
Temp_c	0	50	TranLiveObs_21: temp_c

Coded Value Domain Checks (lists of acceptable values)

Domain	Values	Table and fields applied to
Stratum	'LSTS'	Transects_21: stratum, Waypoints_21: stratum, OppCarcObs_21: stratum, TranCarcObs_21: stratum, TranLiveObs_21: stratum
Group	'GBI'	Transects_21: group_, Waypoints_21: group_, OppCarcObs_21: group_, TranCarcObs_21: group_, TranLiveObs_21: group_,

Terrain_obstacles	'Boundary','Cliff','Cliff;Deep Washes','Cliff;Deep Washes;Prohibited Access','Cliff;Deep Washes;Prohibited Access;Boundary','Cliff;Prohibited Access;Boundary','Cliff;Major Road','Deep Washes','Major Road','Mountainous','Mountainous;Boundary','Mountainous;Cliff','Mountainous;Cliff;Boundary','Mountainous;Cliff;Deep Washes','Mountainous;Cliff;Deep Washes;Boundary','Mountainous;Cliff;Deep Washes;Major Road','Mountainous;Cliff;Deep Washes;Prohibited Access','Mountainous;Cliff;Deep Washes;Prohibited Access;Boundary','Mountainous;Cliff;Deep Washes;Prohibited Access;Major Road','Mountainous;Cliff;Deep Washes;Prohibited Access;Major Road;Boundary','Mountainous;Cliff;Major Road','Mountainous;Cliff;Major Road;Boundary','Mountainous;Cliff;Prohibited Access','Mountainous;Deep Washes','Mountainous;Deep Washes;Boundary','Mountainous;Deep Washes;Prohibited Access','Mountainous;Major Road','Mountainous;Prohibited Access','Mountainous;Prohibited Access;Major Road','Mountainous;Prohibited Access;Major Road;Boundary','None','Prohibited Access','Prohibited Access;Boundary','Prohibited Access;Major Road'	Transects_21: terr_obstacles
Substrate_obstacles	'Gravel', 'Gravel;Sand', 'Gravel;Talus', 'Gravel;Talus;Sand', 'None', 'Rock', 'Rock;Gravel', 'Rock;Gravel;Sand', 'Rock;Gravel;Talus', 'Rock;Gravel;Talus;Sand', 'Rock;Talus', 'Rock;Talus;Sand', 'Rock;Sand', 'Sand', 'Talus', 'Talus;Sand'	Transects_21: subs_obstacles
Observer_position	'Lead', 'Follow'	TranCarcObs_21: observer_position, TranLiveObs_21: observer_position
Lead_Follow	'Observer1', 'Observer2'	Waypoints_21: lead, Waypoints_21: follow, TranLiveObs_21:observer, TranCarcObs_21:observer
Utm_zone	'11', '12'	Waypoints_21: utm_zone, OppCarcObs_21: utm_zone, TranCarcObs_21: utm_zone, TranLiveObs_21: utm_zone,

Yes_No	'No', 'Yes'	OppCarcObs_21: gps_grab_success new_tag_attached, tort_voided, fluids_offered, gps_grab_success TranCarcObs_21: gps_grab_success TranLiveObs_21: temp_greater_35C, new_tag_attached, tort_voided, fluids_offered, gps_grab_success Waypoints_21: gps_grab_success Transects_21: tran_standard PlannedTransects_all: walked_07, walked_08, shifted_after_08
Yes_No_Unknown	'No', 'Yes', 'Unknown'	OppCarcObs_21: mcl_greater_180 TranCarcObs_21: mcl_greater_180 TranLiveObs_21: mcl_greater_180, fluids_accepted PlannedTransects_all: inside_stratum
Existing_tag_live	'No', 'Yes', 'Unknown', 'Unreadable'	TranLiveObs_21:existing_tag
Existing_tag_carc	'No', 'Yes', 'Unreadable'	OppCarcObs_21:existing_tag, TranCarcObs_21:existing_tag
Carc_condition	'Intact', 'Disarticulated'	OppCarcObs_21: carc_condition, TranCarcObs_21: carc_condition
Sex	'Male', 'Female', 'Unknown'	OppCarcObs_21: sex, TranCarcObs_21: sex, TranLiveObs_21: sex
High_Med_Low	'High', 'Medium', 'Low'	TranLiveObs_21: burrow_visibility, tort_in_burrow_visibility, tort_visibility
TortLocation	'Burrow', 'Open', 'Pallet', 'Rock', 'Vegetation', 'SoilBurrow', 'RockBurrow'	TranLiveObs_21: tort_location
CueToTortoise	'Audible', 'BodyPart', 'Burrow', 'BurrowApron', 'Movement', 'SearchedVeg'	TranLiveObs_21: cue_to_tortoise
TortHeading	'HeadOn', 'HeadOn;HeadIntoBurrow', 'HeadOn;HeadOutOfBurrow', 'HeadOn;Profile', 'HeadIntoBurrow', 'HeadOutOfBurrow', 'HeadOutOfBurrow;HeadOn', 'Profile', 'Profile;HeadIntoBurrow', 'Profile;HeadOutOfBurrow', 'PulledIntoShell', 'TailOn', 'TailOn;HeadIntoBurrow', 'TailOn;PulledIntoShell'	TranLiveObs_21: tort_heading
BodyCondScore	'3', '4', '5', '6', '7', 'Unknown'	TranLiveObs_21: body_condition_score,
NaresAppearance	'Normal', 'Asymmetrical', 'Asymmetrical;Eroded', 'Asymmetrical;Occluded', 'Asymmetrical;Eroded;Occluded', 'Eroded', 'Occluded', 'Unknown'	TranLiveObs_21: nares_appearance,

NaresDischarge	'None', 'Serous1', 'Serous2', 'Serous3', 'Mucous1', 'Mucous2', 'Mucous3', 'Unknown'	TranLiveObs_21: nares_discharge,
Ticks	'0', '1-10', '>10', 'Unknown'	TranLiveObs_21: ticks,
TortVoid	'None', 'Urine', 'Feces', 'Both'	TranLiveObs_21: tort_void,
TortNotHandled	'deep in burrow', 'deep in vegetation', 'temperature', 'scutes too small', 'social interaction', 'too windy'	TranLiveObs_21: tort_not_handled,
Interrupted	'No', 'Yes'	Transects_21:interrupted_tran

Duplicate Checks

Table	Check
Transects_21	contains duplicate tran_num values
Transects_21	contains duplicate tran_prime_key values
Waypoints_21	contains duplicate tran_num and wp_num values
Waypoints_21	contains duplicate wp_key values
OppCarcObs_21	contains duplicate tran_num and detection_number values
OppCarcObs_21	contains duplicate obs_key values
TranCarcObs_21	contains duplicate tran_num and detection_number values
TranCarcObs_21	contains duplicate obs_key values
TranLiveObs_21	contains duplicate tran_num and detection_number values
TranLiveObs_21	contains duplicate obs_key values
Transects_21	multiple dates for segments of interrupted transect

SQL checks (involves multiple tables)

Table	SQL Check
Waypoints_21	waypoint stratum does not match transect stratum (join based on tran_prime_key)
OppCarcObs_21	oppcarcobs stratum does not match transect stratum (join based on tran_prime_key)
TranCarcObs_21	trancarcobs stratum does not match transect stratum (join based on tran_prime_key)
TranLiveObs_21	tranliveobs stratum does not match transect stratum (join based on tran_prime_key)
Waypoints_21	waypoint stratum does not match transect stratum (join based on tran_num)
OppCarcObs_21	oppcarcobs stratum does not match transect stratum (join based on tran_num)
TranCarcObs_21	trancarcobs stratum does not match transect stratum (join based on tran_num)
TranLiveObs_21	tranliveobs stratum does not match transect stratum (join based on tran_num)
Waypoints_21	waypoint tran_num does not match transect tran_num
OppCarcObs_21	oppcarcobs tran_num does not match transect tran_num
TranCarcObs_21	trancarcobs tran_num does not match transect tran_num
TranLiveObs_21	tranliveobs tran_num does not match transect tran_num
Waypoints_21	waypoint team_num does not match transect team_num
OppCarcObs_21	oppcarcobs team_num does not match transect team_num
TranCarcObs_21	trancarcobs team_num does not match transect team_num

TranLiveObs_21	tranliveobs team_num does not match transect team_num
Transects_21	observer1 and group does not match observer and group in the Observers table
Transects_21	observer2 and group does not match observer and group in the Observers table
TranCarcObs_21	observation tran_prime_key and last_wp do not match an existing waypoint
TranLiveObs_21	observation tran_prime_key and last_wp do not match an existing waypoint
Transects_21	team_num, group_, or observer1 and observer2 do not match the Teams table
Transects_21	transect does not have any associated waypoints
Waypoints_21	waypoint does not have an associated transect
TranLiveObs_21	tranliveobs does not have an associated transect
TranCarcObs_21	trancarcobs does not have an associated transect
OppCarcObs_21	oppcarcobs does not have an associated transect
Transects_21	transect does not have an associated team
Transects_21	transect does not have an associated observer1 in the observers table
Transects_21	transect does not have an associated observer2 in the observers table
Transects_21	transect does not have an associated stratum
Waypoints_21	waypoint does not have an associated stratum
OppCarcObs_21	oppcarcobs does not have an associated stratum
TranCarcObs_21	trancarcobs does not have an associated stratum
TranLiveObs_21	tranliveobs does not have an associated stratum
Transects_21	comments field contains a carriage return
Waypoints_21	comments field contains a carriage return
TranCarcObs_21	comments field contains a carriage return
TranLiveObs_21	comments field contains a carriage return
OppCarcObs_21	comments field contains a carriage return
Waypoints_21	waypoint date from TimeStamp does not match transect date_
OppCarcObs_21	oppcarcobs date from TimeStamp does not match transect date_
TranCarcObs_21	trancarcobs date from TimeStamp does not match transect date_
TranLiveObs_21	tranliveobs date from TimeStamp does not match transect date_
Waypoints_21	time is before or after transect start_time and end_time
TranCarcObs_21	time is before or after transect start_time and end_time
TranLiveObs_21	time is before or after transect start_time and end_time
TranCarcObs_21	time is before last_wp
TranCarcObs_21	time is after next_wp
TranLiveObs_21	time is before last_wp
TranLiveObs_21	time is after next_wp
TranCarcObs_21	observer_position from observation does not match position from waypoints table
TranLiveObs_21	observer_position from observation does not match position from waypoints table
Transects_21	num_oppcarcobs does not match the number of observations in the OppCarcObs table
Transects_21	num_oppliveobs does not match the number of observations in the OppLiveObs table
Transects_21	num_trancarcobs does not match the number of observations in the TranCarcObs table
Transects_21	num_tranliveobs does not match the number of observations in the TranLiveObs table
TranLiveObs_21	TranLiveObs trn_length_at_last_wp does not match Waypoint trans_length_at_wp
TranCarcObs_21	TranCarcObs trn_length_at_last_wp does not match Waypoint trans_length_at_wp

Transects_21	Transects trn_length_m does not match waypoint 99 trans_length_at_wp
Transects_21	missing waypoint 0
Transects_21	missing waypoint 1
Transects_21	missing waypoint 99
Transects_21	missing waypoint 100
Waypoints_21	wp_num is 0 and time_ is not within 30 minutes of transect do_time
Waypoints_21	wp_num is 1 and time_ is not within 30 minutes of transect tran_start_time
Waypoints_21	wp_num is 99 and time_ is not within 30 minutes of transect tran_end_time
Waypoints_21	wp_num is 100 and time_ is not within 30 minutes of transect ret_do_time

Spatial checks for related features

Table	Check
TranCarcObs_21	observation is not within 50 meters of its related transect line
TranLiveObs_21	observation is not within 50 meters of its related transect line
Transects_21	Transect does not intersect its related stratum

Transects_21 field checks

tran_num is null
TimeStamp is null
stratum is blank or null
date is null
date_ does not match date from TimeStamp_
group_ is GBI and date is before 3/30/2021 or after 4/1/2021
group_ is GBI and team_num is not between 11 and 27
team_num is null
group_ is blank or null
observer1 is blank or null
observer2 is blank or null
Observer1 and Observer2 are the same
do_time is null
tran_start_time is null
tran_end_time is null
ret_do_time is null
do_time is after tran_start_time
tran_start_time is after tran_end_time
tran_end_time is after ret_do_time
tran_standard is blank or null
tran_standard is Yes but transect was interrupted
tran_standard is Yes but terr_obstacles is not null
tran_standard is Yes but subs_obstacles is not null
tran_standard is Yes but other_obstacles is not null
tran_standard is No with no descriptive information
tran_standard is Yes but unplanned_mod is also Yes
unplanned_mod is Yes with no terrain or substrate obstacles
data_sheet does not match stratum and tran_num concatenation
comments contains special character
comments are blank, should be null
other_obstacles contains special character
total_time_hrs does not match tran_end_time - tran_start_time
tran_num is not suffixed by .9 but type_21 is Yes
tran_standard is Yes but length is less than 10k
non-interrupted shorter than 11,500 m

Waypoints_21 field checks

tran_num is null
TimeStamp_ is null
stratum is blank or null
wp_num is null
easting is Null
northing is Null
time_ is null
lead and follow are the same
wp_num is 0 but lead and follow are not null
wp_num is 99 but lead and follow are not null
wp_num is 100 but lead and follow are not null
lead or follow is null
crew interrupted transect but lead and follow are not null
waypoint is 0, 1, 99, or 100 but end_tran_part is Yes
waypoint is 0, 1, or 100 but burrow_ct is not null
elev_m is null
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No
manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is blank or null
utm_zone is 11S but easting does not match gps_easting or manual_easting
utm_zone is 11S but northing does not match gps_northing or manual_northing
manual_zone is not Null but manual_easting or manual_northing are Null
utm_zone is 11S but z12 easting and northing fields are not null
utm_zone is 12S but z12 easting or northing fields are null
segment_length is 0 but waypoint is not number 0, 1, 100 or a continuation waypoint
photo_to_wp_xplus1_file does not follow convention
photo_to_wp_xminus1_file does not follow convention
comments contains special character
comments are blank, should be null

TranCarcObs_21 field checks

tran_num is null
TimeStamp_ is null
detection_number is null
stratum is blank or null
time_ is not within 10 minutes of time from TimeStamp_
last_wp is null
time_ is null
observer_position is null
observer is null
tran_bearing is null
local_bearing is null
azimuth is null
radial_distance_m is null
perp_distance_m is null
local_bearing is not within 20 degrees of tran_bearing
perp_distance_m is greater than radial_distance_m
radial distance has two decimal places
perp_distance_m does not match calculated perp_distance_m
easting is Null

northing is Null
elev_m is null
existing_tag is Yes, but existing_tag_number or existing_tag_color is null
existing_tag is No, but existing_tag_number and existing_tag_color are not null
carc_condition is blank or null
inconsistency between carc_condition and mcl_mm
mcl_mm is 180 or greater but mcl_greater_180 is not Yes
mcl_mm is less than 180 but mcl_greater_180 is not No
sex is blank or Null (should be unknown)
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No
manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is blank or null
utm_zone is 11S but easting does not match gps_easting or manual_easting
utm_zone is 11S but northing does not match gps_northing or manual_northing
manual_zone is not Null but manual_easting or manual_northing are Null
utm_zone is 11S but z12 easting and northing fields are not null
utm_zone is 12S but z12 easting or northing fields are null
photo_carc_file does not follow convention
comments contains special character
comments are blank, should be null

TranLiveObs_21 field checks

tran_num is null
TimeStamp_ is null
detection_number is null
stratum is blank or null
time_ is not within 10 minutes of time from TimeStamp_
last_wp is null
time_ is null
observer_position is null
observer is null
tran_bearing is null
local_bearing is null
azimuth is null
radial_distance_m is null
perp_distance_m is null
local_bearing is not within 20 degrees of tran_bearing
perp_distance_m is greater than radial_distance_m
radial distance has two decimal places
perp_distance_m does not match calculated perp_distance_m
easting is Null
northing is Null
elev_m is null
new_tag_attached is blank or null
new_tag_attached is Yes but new_tag_number is null
new_tag_attached is No but new_tag_number is not null
existing_tag is Yes, but existing_tag_number or existing_tag_color is null
existing_tag is No, but existing_tag_number and existing_tag_color are not null
inconsistency between existing_tag and new_tag_attached
existing_tag is No and new_tag_attached is null, should be Yes or No
mcl_mm is 180 or greater but mcl_greater_180 is not Yes
mcl_mm is less than 180 but mcl_greater_180 is not No

tort_void is Yes but fluids_offered is not Yes

fluids_offered is Yes but fluids_accepted is not Yes, No Unknown

sex is blank or Null (should be unknown)

gps_bluetooth is null but gps_grab_success is not No

manual_easting or manual_northing are null and gps_grab_success is No

manual_easting or manual_northing are not null and gps_grab_success is Yes

utm_zone is blank or null

utm_zone is 11S but easting does not match gps_easting or manual_easting

utm_zone is 11S but northing does not match gps_northing or manual_northing

manual_zone is not Null but manual_easting or manual_northing are Null

utm_zone is 11S but z12 easting and northing fields are not null

utm_zone is 12S but z12 easting or northing fields are null

photo_tort1_file does not follow convention

photo_tort2_file does not follow convention

comments contains special character

comments are blank, should be null

tort_location is blank or null

inconsistency between tort_location and mcl_mm

tort_location is not Burrow but burrow_visibility or tort_in_burrow_visibility are not null

tort_location is Burrow but tort_visibility is not null

tort_location is not Burrow but tort_visibility is null

tort_location is Burrow but burrow_visibility or tort_in_burrow_visibility is null

tort_void is blank or null

Appendix B: 2021 Preseason Training Line Database Final QA/QC Rules

Relationship Checks

From Table	Primary Key	To Table	Foreign Key	Cardinality Rules
Train_Tran_21	Train_prime_key	Train_Obs_21	Train_prime_key	1 to Many
Train_Teams_21	team_num	Train_Tran_21	team_num	1 to Many
Train_TortInfo_21	tortoise_id	Train_Obs_21	tortoise_id	1 to Many

Range Domain Checks

Domain	Low_value	High_value	Table and fields applied to
TrialNum	1	3	Train_Tran_21.trial_number, Train_Obs_21.trial_number
TeamNum	1	27	Train_Tran_21.team_num, Train_Obs_21.team_num
TranSegNum	1	8	Train_Tran_21.transect_seg_num
TrainDate	3/16/2021	3/30/2021	Train_Tran_21.training_date, Train_Obs_21.training_date Train_Tran_21.TimeStamp_, Train_Obs_21.TimeStamp_
TrainTime	5:00:00 AM	6:00:00 PM	Train_Tran_21.training_start_time Train_Tran_21.training_end_time Train_Obs_21.observation_time
TotalTime	0	10	Train_Tran_21.total_time
TortID	0	288	Train_Obs_21.tortoise_id
LocalBearing	0	360	Train_Obs_21.local_bearing
Azimuth	0	360	Train_Obs_21.azimuth
RadDistance	0	60	Train_Obs_21.radial_distance_m

Coded Value Domain Rules

domain_name	domain_values	Table and fields applied to
TrainingLineColor	'Red', 'Yellow', 'Magenta', 'White', 'Orange', 'Green'	Train_Tran_21.training_line_color, Train_Obs_21.training_line_color

StartPost	'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K', 'L'	Train_Tran_21.start_post
TransectBearing	35, 215	Train_Tran_21.transect_bearing, Train_Obs_21.transect_bearing
Transect	'Red_1', 'Red_2', 'Red_5', 'Red_6', 'Yellow_1', 'Yellow_2', 'Yellow_5', 'Yellow_6', 'Magenta_1', 'Magenta_2', 'Magenta_5', 'Magenta_6', 'White_3', 'White_4', 'White_7', 'White_8', 'Orange_3', 'Orange_4', 'Orange_7', 'Orange_8', 'Green_3', 'Green_4', 'Green_7', 'Green_8'	Train_Tran_21.transect, Train_Obs_21.transect
Group	'Kiva'	Train_Tran_21.group_
ObsPosition	'Lead', 'Follow'	Train_Obs_21.observer_position
TortSize	'Adult', 'Immature'	Train_Obs_21.tortoise_size
OrigObservation	'from line', 'while at another model'	Train_Obs_21.original_observation

Duplicate Checks

Table	Check
Train_Tran_21	contains duplicate train_prime_key values
Train_Tran_21	contains duplicate trial_number, team_number, transect values
Train_Obs_21	contains duplicate train_obs_key values
Train_Obs_21	contains duplicate tortoise_id, trial_number, training_date, team_num, training_line_color values

SQL checks (involves multiple tables)

Table	SQL Check
Train_Tran_21	lead, follow, or group_do not match the teams table based on team_num and trial_number
Train_Tran_21	training transect does not have any associated observations
Train_Obs_21	training observation does not have an associated training transect
Train_Tran_21	training transect does not have an associated team and trial
Train_Obs_21	training observation does not have an associated tortoise_id in Train_TortInfo_21
Train_Obs_21	observer_name and observer_position do not match lead or follow in Train_Tran table
Train_Obs_21	observation_time is not between training_start_time and training_end_time
Train_Obs_21	team_num, training_line_color, transect, training_date, tran_bearing or configuration do not match Train_Tran table
Train_Obs_21	group_ does not match group_ in Train_Tran table
Train_Obs_21	observer_name does not match the teams table for this trial_number and team_num
Train_Obs_21	tortoise_id and tortoise_size do not match TortInfo table
Train_Obs_21	perp_dist_m is more than 8 meters different than expected
Train_Obs_21	tortoise_id is not in TortoiseLookup table for the training_line_color

Train_Tran_21 field checks

trial_number Is Null
team_num Is Null
training_line_color Is Null
start_post Is Null
tran_bearing Is Null
transect_seg_num Is Null
transect Is Null
training_date Is Null
training_start_time Is Null
group_ Is Null
lead Is Null
follow Is Null
training_end_time Is Null
total_time Is Null
data_sheet Is Null
ID Is Null
TimeStamp year is out of range
training_date does not match timestamp date
comments contain special character
comments are blank, should be null
training_start_time is after training_end_time
transect does not match training line color and transect_seg_num
transect_seg_num is 1, but startpost, tran_bearing are not A, 215 or B, 35
transect_seg_num is 2, but startpost, tran_bearing are not B, 215 or C, 35
transect_seg_num is 3, but startpost, tran_bearing are not D, 215 or E, 35
transect_seg_num is 4, but startpost, tran_bearing are not E, 215 or F, 35
transect_seg_num is 5, but startpost, tran_bearing are not G, 215 or H, 35
transect_seg_num is 6, but startpost, tran_bearing are not H, 215 or I, 35
transect_seg_num is 7, but startpost, tran_bearing are not J, 215 or K, 35
transect_seg_num is 8, but startpost, tran_bearing are not K, 215 or L, 35
lead and follow are the same
datasheet does not match group, trial, team, date concatenation
total_time does not match training_end_time - training_start_time

Train_Obs_21 field checks

trial_number Is Null
team_num Is Null
training_line_color Is Null
tran_bearing Is Null
transect Is Null
training_date Is Null
ID Is Null
observation_time Is Null
observer_name Is Null
observer_position Is Null
tortoise_size Is Null
tortoise_id Is Null
local_bearing Is Null
azimuth Is Null
radial_distance_m Is Null
bearing_radians Is Null
azimuth_radians Is Null

perp_dist_m Is Null
original_observation Is Null
TimeStamp year is out of range
training_line_color does not match transect
comments contain special character
comments are blank, should be null
local bearing not within 40 degrees of tran bearing
radial_distance_m has more than one decimal place
perp_dist_m is greater than 25m
perp_dist_m does not match calculated perp_dist_m
bearing_radians does not match calculated bearing_radians
azimuth_radians does not match calculated azimuth_radians
perp_dist_m is greater than radial_distance_m

Appendix C: 2021 Season Transects Database Final QA/QC Rules

Relationship Checks

From Table	Primary Key	To Table	Foreign Key	Cardinality Rules
Transects_21	tran_prime_key	Waypoints_21	tran_prime_key	1 to Many
Transects_21	tran_prime_key	OppCarcObs_21	tran_prime_key	1 to Many
Transects_21	tran_prime_key	OppLiveObs_21	tran_prime_key	1 to Many
Transects_21	tran_prime_key	TranCarcObs_21	tran_prime_key	1 to Many
Transects_21	tran_prime_key	TranLiveObs_21	tran_prime_key	1 to Many
Teams_21	team_num	Transects_21	team_num	1 to Many
Observers_21	observer	Transects_21	observer1	1 to Many
Observers_21	observer	Transects_21	observer2	1 to Many
StrataBnd_21	stratum	Transects_21	stratum	1 to Many
StrataBnd_21	stratum	Waypoints_21	stratum	1 to Many
StrataBnd_21	stratum	OppCarcObs_21	stratum	1 to Many
StrataBnd_21	stratum	OppLiveObs_21	stratum	1 to Many
StrataBnd_21	stratum	TranCarcObs_21	stratum	1 to Many
StrataBnd_21	stratum	TranLiveObs_21	stratum	1 to Many

Range Domain Checks (numeric or date ranges of acceptable values)

Domain	Low value	High value	Table and fields applied to
Drop_Start_time	4:00:00 AM	10:00:00 AM	Transects_21: do_time, Transects_21: tran_start_time
End_Ret_time	8:00:00 AM	6:30:00 PM	Transects_21: tran_end_time, Transects_21: ret_do_time
Time	4:00:00 AM	6:30:00 PM	Waypoints_21: time_, TranCarcObs_21: time_, TranLiveObs_21: time_
TranNum	1	6650	Transects_21: tran_num, Waypoints_21: tran_num, OppCarcObs_21: tran_num, OppLiveObs_21: tran_num, TranCarcObs_21: tran_num, TranLiveObs_21: tran_num,
TranDate	3/6/2021	5/19/2021	Transects_21:date_, Transects_21: TimeStamp_, Waypoint_21: TimeStamp_, OppCarcObs_21: TimeStamp_, OppLiveObs_21: TimeStamp_, TranCarcObs_21: TimeStamp_, TranLiveObs_21: TimeStamp_
Team_num	1	27	Transects_21:team_num, Waypoints_21: team_num, OppCarcObs_21: team_num, OppLiveObs_21: team_num, TranCarcObs_21: team_num, TranLiveObs_21: team_num,
TranLength	6500	12500	Transects.trn_length_m
Wp_num	0	100	Waypoints_21:wp_num
BurrowCt	0	30	Waypoints_21.burrow_ct

Last_wp	1	30	TranCarcObs_21: last_wp, TranLiveObs_21: last_wp
Easting	408849	794114	Waypoints_21:easting, OppCarcObs_21:easting, OppLiveObs_21:easting, TranCarcObs_21:easting, TranLiveObs_21:easting, PlannedTransects_all: sw_easting
Northing	3648506	4133135	Waypoints_21:northing, OppCarcObs_21:northing, OppLiveObs_21:northing, TranCarcObs_21:northing, TranLiveObs_21:northing, PlannedTransects_all: sw_northing
Elevation	0	1800	Waypoints_21: elev_m, OppCarcObs_21: elev_m, OppLiveObs_21: elev_m, TranCarcObs_21: elev_m, TranLiveObs_21: elev_m
Num_live_obs	0	15	OppLiveObs: detection_number TranLiveObs: detection_number Transects: num_oppliveobs, num_tranliveobs
Num_carc_obs	0	20	OppCarcObs: detection_number TranCarcObs: detection_number Transects: num_oppcarcobs, num_trancarcobs
Bearing	0	360	TranCarcObs_21: tran_bearing, local_bearing TranLiveObs_21: tran_bearing, local_bearing
Azimuth	0	360	TranCarcObs_21: azimuth, TranLiveObs_21: azimuth
Distance_to_burrow	0	100	TranLiveObs_21:dist_to_burrow, OppLiveObs_21:dist_to_burrow
Radial_distance	0	60	TranCarcObs_21: radial_distance_m, TranLiveObs_21: radial_distance_m
Perp_distance	0	50	TranCarcObs_21: perp_distance_m, TranLiveObs_21: perp_distance_m
Mcl_mm	1	400	OppCarcObs_21: mcl_mm, OppLiveObs_21: mcl_mm, TranCarcObs_21: mcl_mm, TranLiveObs_21: mcl_mm
Temp_c	0	50	OppLiveObs_21: temp_c, TranLiveObs_21: temp_c

Coded Value Domain Checks (lists of acceptable values)

Domain	Values	Table and fields applied to
Stratum	'AG', 'CK', 'FE', 'GB', 'IV', 'MM', 'OR', 'PV'	Transects_21: stratum, Waypoints_21: stratum, OppCarcObs_21: stratum, OppLiveObs_21: stratum, TranCarcObs_21: stratum, TranLiveObs_21: stratum
Group	'Kiva', 'GBI'	Transects_21: group_, Waypoints_21: group_, OppCarcObs_21: group_,

		OppLiveObs_21: group_, TranCarcObs_21: group_, TranLiveObs_21: group_,
Terrain_obstacles	'Boundary','Cliff','Cliff;Deep Washes','Cliff;Deep Washes;Prohibited Access','Cliff;Deep Washes;Prohibited Access;Boundary','Cliff;Deep Washes;Boundary','Cliff;Deep Washes;Major 'Boundary','Cliff','Cliff;Deep Washes','Cliff;Deep Washes;Prohibited Access','Cliff;Deep Washes;Prohibited Access;Boundary','Cliff;Deep Washes;Boundary','Cliff;Deep Washes;Major Road;Boundary','Cliff;Prohibited Access;Boundary','Cliff;Major Road','Deep Washes','Deep Washes;Boundary','Major Road','Mountainous','Mountainous;Boundary','Mountainous;Cliff','Mountainous;Cliff;Boundary','Mountainous;Cliff;Deep Washes','Mountainous;Cliff;Deep Washes;Boundary','Mountainous;Cliff;Deep Washes;Major Road','Mountainous;Cliff;Deep Washes;Prohibited Access','Mountainous;Cliff;Deep Washes;Prohibited Access;Boundary','Mountainous;Cliff;Deep Washes;Prohibited Access;Major Road','Mountainous;Cliff;Deep Washes;Prohibited Access;Major Road;Boundary','Mountainous;Cliff;Major Road','Mountainous;Cliff;Major Road;Boundary','Mountainous;Cliff;Prohibited Access','Mountainous;Cliff;Prohibited Access;Boundary','Mountainous;Deep Washes','Mountainous;Deep Washes;Boundary','Mountainous;Deep Washes;Prohibited Access','Mountainous;Major Road','Mountainous;Prohibited Access','Mountainous;Prohibited Access;Major Road','Mountainous;Prohibited Access;Major Road;Boundary','None','Prohibited Access','Prohibited Access;Boundary','Prohibited Access;Major Road','Major Road;Boundary'	Transects_21: terr_obstacles

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Substrate_obstacles	'Gravel', 'Gravel;Sand', 'Gravel;Talus', 'Gravel;Talus;Sand', 'None', 'Rock', 'Rock;Gravel', 'Rock;Gravel;Sand', 'Rock;Gravel;Talus', 'Rock;Gravel;Talus;Sand', 'Rock;Talus', 'Rock;Talus;Sand', 'Rock;Sand', 'Sand', 'Talus', 'Talus;Sand'	Transects_21: subs_obstacles
Observer_position	'Lead', 'Follow'	TranCarcObs_21: observer_position, TranLiveObs_21: observer_position
Lead_Follow	'Observer1', 'Observer2'	Waypoints_21: lead, Waypoints_21: follow, TranLiveObs_21:observer, TranCarcObs_21:observer
Utm_zone	'11', '12'	Waypoints_21: utm_zone, OppCarcObs_21: utm_zone, OppLiveObs_21: utm_zone, TranCarcObs_21: utm_zone, TranLiveObs_21: utm_zone,
Yes_No	'No', 'Yes'	OppCarcObs_21: gps_grab_success OppLiveObs_21: temp_greater_35C, new_tag_attached, tort_voided, fluids_offered, gps_grab_success TranCarcObs_21: gps_grab_success TranLiveObs_21: temp_greater_35C, new_tag_attached, tort_voided, fluids_offered, gps_grab_success Waypoints_21: gps_grab_success Transects_21: tran_standard PlannedTransects_all: walked_07, walked_08, shifted_after_08
Yes_No_Unknown	'No', 'Yes', 'Unknown'	OppCarcObs_21: mcl_greater_180 OppLiveObs_21: mcl_greater_180, fluids_accepted TranCarcObs_21: mcl_greater_180 TranLiveObs_21: mcl_greater_180, fluids_accepted PlannedTransects_all: inside_stratum
Existing_tag_live	'No', 'Yes', 'Unknown', 'Unreadable'	OppLiveObs_21:existing_tag, TranLiveObs_21:existing_tag
Existing_tag_carc	'No', 'Yes', 'Unreadable'	OppCarcObs_21:existing_tag, TranCarcObs_21:existing_tag
Carc_condition	'Intact', 'Disarticulated'	OppCarcObs_21: carc_condition, TranCarcObs_21: carc_condition
Sex	'Male', 'Female', 'Unknown'	OppCarcObs_21: sex, OppLiveObs_21: sex, TranCarcObs_21: sex, TranLiveObs_21: sex
High_Med_Low	'High', 'Medium', 'Low'	OppLiveObs_21: burrow_visibility, tort_in_burrow_visibility, tort_visibility TranLiveObs_21:

		burrow_visibility, tort_in_burrow_visibility, tort_visibility
TortLocation	'Burrow', 'Open', 'Pallet', 'Rock', 'Vegetation', 'SoilBurrow', 'RockBurrow'	OppLiveObs_21: tort_location, TranLiveObs_21: tort_location
CueToTortoise	'Audible', 'BodyPart', 'Burrow', 'BurrowApron', 'Movement', 'SearchedVeg'	TranLiveObs_21: cue_to_tortoise
TortHeading	'HeadOn', 'HeadOn;HeadIntoBurrow', 'HeadOn;HeadOutOfBurrow', 'HeadOn;Profile', 'HeadIntoBurrow', 'HeadOutOfBurrow', 'HeadOutOfBurrow;HeadOn', 'Profile', 'Profile;HeadIntoBurrow', 'Profile;HeadOutOfBurrow', 'PulledIntoShell', 'TailOn', 'TailOn;HeadIntoBurrow', 'TailOn;PulledIntoShell'	TranLiveObs_21: tort_heading
BodyCondScore	'3', '4', '5', '6', '7', 'Unknown'	TranLiveObs_21: body_condition_score, OppLiveObs_21: body_condition_score
NaresAppearance	'Normal', 'Asymmetrical', 'Asymmetrical;Eroded', 'Asymmetrical;Occluded', 'Asymmetrical;Eroded;Occluded', 'Eroded', 'Occluded', 'Unknown'	TranLiveObs_21: nares_appearance, OppLiveObs_21: nares_appearance
NaresDischarge	'None', 'Serous1', 'Serous2', 'Serous3', 'Mucous1', 'Mucous2', 'Mucous3', 'Unknown'	TranLiveObs_21: nares_discharge, OppLiveObs_21: nares_discharge
Ticks	'0', '1-10', '>10', 'Unknown'	TranLiveObs_21: ticks, OppLiveObs_21: ticks
TortVoid	'None', 'Urine', 'Feces', 'Both'	TranLiveObs_21: tort_void, OppLiveObs_21: tort_void
TortNotHandled	'deep in burrow', 'deep in vegetation', 'temperature', 'scutes too small', 'social interaction', 'too windy'	TranLiveObs_21: tort_not_handled, OppLiveObs_21: tort_not_handled
Interrupted	'No', 'Yes'	Transects_21:interrupted_tran
Assigned_Alternate	'Assigned', 'Alternate', 'Unavailable', 'Duplicate'	PlannedTransects_all:type_07, type_08, type_09, type_10, type_11, type_12, type_13, type_14, type_15, type_16, type_17, type_18, type_19, type_20, type_21 Transects_21: type_21
Replaced	'Yes', 'No', 'Yes - UP Gate Access', 'Yes - crew failed to assign/replace', 'In plane closure area', 'Moved to alt list', 'Yes (why?)', 'Yes. Access?'	PlannedTransects_all:replaced_07, replaced_08, replaced_09, replaced_10, replaced_11, replaced_12, replaced_13, replaced_14, replaced_15, replaced_16, replaced_17, replaced_18, replaced_21

Substratum	'12k', 'Reduced', 'Unwalkable'	PlannedTransects_all: substratum Transects_21: substrat_obs_21 PlannedTransects_all: substrat_obs_21
ReductionType	'None', 'Major', 'Minor'	Transects_21: reduction_obs_21
Accessible	'Basecamped', 'No', 'No per GBI 2008 report', 'Yes; 2010 gate'	PlannedTransects_all: accessible
Grid_space	'1k', '27k', '3k', '9k'	PlannedTransects_all: grid_space
Point_num	'1', '2', '3', '4', '5', '6', '7', '8', 'ctrpt'	PlannedTransects_all: pt_num

Duplicate Checks

Table	Check
Transects_21	contains duplicate tran_num values
Transects_21	contains duplicate tran_prime_key values
Waypoints_21	contains duplicate tran_num and wp_num values
Waypoints_21	contains duplicate wp_key values
OppCarcObs_21	contains duplicate tran_num and detection_number values
OppCarcObs_21	contains duplicate obs_key values
OppLiveObs_21	contains duplicate tran_num and detection_number values
OppLiveObs_21	contains duplicate obs_key values
TranCarcObs_21	contains duplicate tran_num and detection_number values
TranCarcObs_21	contains duplicate obs_key values
TranLiveObs_21	contains duplicate tran_num and detection_number values
TranLiveObs_21	contains duplicate obs_key values
Transects_21	multiple dates for segments of interrupted transect

SQL checks (involves multiple tables)

Table	SQL Check
Waypoints_21	waypoint stratum does not match transect stratum (join based on tran_prime_key)
OppCarcObs_21	oppcarcobs stratum does not match transect stratum (join based on tran_prime_key)
OppLiveObs_21	oppliveobs stratum does not match transect stratum (join based on tran_prime_key)
TranCarcObs_21	trancarcobs stratum does not match transect stratum (join based on tran_prime_key)
TranLiveObs_21	tranliveobs stratum does not match transect stratum (join based on tran_prime_key)
Waypoints_21	waypoint stratum does not match transect stratum (join based on tran_num)
OppCarcObs_21	oppcarcobs stratum does not match transect stratum (join based on tran_num)
OppLiveObs_21	oppliveobs stratum does not match transect stratum (join based on tran_num)
TranCarcObs_21	trancarcobs stratum does not match transect stratum (join based on tran_num)
TranLiveObs_21	tranliveobs stratum does not match transect stratum (join based on tran_num)
Waypoints_21	waypoint tran_num does not match transect tran_num
OppCarcObs_21	oppcarcobs tran_num does not match transect tran_num
OppLiveObs_21	oppliveobs tran_num does not match transect tran_num
TranCarcObs_21	trancarcobs tran_num does not match transect tran_num
TranLiveObs_21	tranliveobs tran_num does not match transect tran_num

Waypoints_21	waypoint team_num does not match transect team_num
OppCarcObs_21	oppcarcobs team_num does not match transect team_num
OppLiveObs_21	oppliveobs team_num does not match transect team_num
TranCarcObs_21	trancarcobs team_num does not match transect team_num
TranLiveObs_21	tranliveobs team_num does not match transect team_num
Transects_21	observer1 and group does not match observer and group in the Observers table
Transects_21	observer2 and group does not match observer and group in the Observers table
TranCarcObs_21	observation tran_prime_key and last_wp do not match an existing waypoint
TranLiveObs_21	observation tran_prime_key and last_wp do not match an existing waypoint
Transects_21	team_num, group_, or observer1 and observer2 do not match the Teams table
Transects_21	transect does not have any associated waypoints
Waypoints_21	waypoint does not have an associated transect
TranLiveObs_21	tranliveobs does not have an associated transect
TranCarcObs_21	trancarcobs does not have an associated transect
OppLiveObs_21	oppliveobs does not have an associated transect
OppCarcObs_21	oppcarcobs does not have an associated transect
Transects_21	transect does not have an associated team
Transects_21	transect does not have an associated observer1 in the observers table
Transects_21	transect does not have an associated observer2 in the observers table
Transects_21	transect does not have an associated stratum
Waypoints_21	waypoint does not have an associated stratum
OppCarcObs_21	oppcarcobs does not have an associated stratum
OppLiveObs_21	oppliveobs does not have an associated stratum
TranCarcObs_21	trancarcobs does not have an associated stratum
TranLiveObs_21	tranliveobs does not have an associated stratum
Transects_21	comments field contains a carriage return
Waypoints_21	comments field contains a carriage return
TranCarcObs_21	comments field contains a carriage return
TranLiveObs_21	comments field contains a carriage return
OppCarcObs_21	comments field contains a carriage return
OppLiveObs_21	comments field contains a carriage return
Waypoints_21	waypoint date from TimeStamp does not match transect date_
OppCarcObs_21	oppcarcobs date from TimeStamp does not match transect date_
OppLiveObs_21	oppliveobs date from TimeStamp does not match transect date_
TranCarcObs_21	trancarcobs date from TimeStamp does not match transect date_
TranLiveObs_21	tranliveobs date from TimeStamp does not match transect date_
Waypoints_21	time is before or after transect start_time and end_time
TranCarcObs_21	time is before or after transect start_time and end_time
TranLiveObs_21	time is before or after transect start_time and end_time
TranCarcObs_21	time is before last_wp
TranCarcObs_21	time is after next_wp
TranLiveObs_21	time is before last_wp
TranLiveObs_21	time is after next_wp
TranCarcObs_21	observer_position from observation does not match position from waypoints table
TranLiveObs_21	observer_position from observation does not match position from waypoints table
Transects_21	num_oppcarcobs does not match the number of observations in the OppCarcObs table
Transects_21	num_oppliveobs does not match the number of observations in the OppLiveObs table

Transects_21	num_trancarcobs does not match the number of observations in the TranCarcObs table
Transects_21	num_tranliveobs does not match the number of observations in the TranLiveObs table
TranLiveObs_21	TranLiveObs trn_length_at_last_wp does not match Waypoint trans_length_at_wp
TranCarcObs_21	TranCarcObs trn_length_at_last_wp does not match Waypoint trans_length_at_wp
Transects_21	Transects trn_length_m does not match waypoint 99 trans_length_at_wp
Transects_21	missing waypoint 0
Transects_21	missing waypoint 1
Transects_21	missing waypoint 99
Transects_21	missing waypoint 100
Waypoints_21	wp_num is 0 and time_ is not within 30 minutes of transect do_time
Waypoints_21	wp_num is 1 and time_ is not within 30 minutes of transect tran_start_time
Waypoints_21	wp_num is 99 and time_ is not within 30 minutes of transect tran_end_time
Waypoints_21	wp_num is 100 and time_ is not within 30 minutes of transect ret_do_time
Transects_21	stratum in Transects table does not match stratum in Planned Transects table
Transects_21	date_ in Transects table does not match date_walked in Planned Transects table
PlannedTransects_all	Transect exists but Planned Transects walked_21 is No
PlannedTransects_all	date_walked in Planned Transects table does not match date_ in Transects table
PlannedTransects_all	type_21 in PlannedTransects table does not match Transect type_21

Spatial checks for related features

Table	Check
TranCarcObs_21	observation is not within 50 meters of its related transect line
TranLiveObs_21	observation is not within 50 meters of its related transect line
OppCarcObs_21	opportunistic observation is not within 600 meters of its related transect line
OppLiveObs_21	opportunistic observation is not within 600 meters of its related transect line
Transects_21	Transect does not intersect its related stratum

Transects_21 field checks

tran_num is null
TimeStamp is null
stratum is blank or null
date is null
date_ does not match date from TimeStamp_
group_ is Kiva and date is before 3/6/2021 or after 5/19/2021
group_ is Kiva and team_num is not 5 or less
group_ is GBI and date is before 4/5/2021 or after 5/19/2021
group_ is GBI and team_num is not between 11 and 27
team_num is null
group_ is blank or null
observer1 is blank or null
observer2 is blank or null
Observer1 and Observer2 are the same
do_time is null
tran_start_time is null
tran_end_time is null
ret_do_time is null

do_time is after tran_start_time
tran_start_time is after tran_end_time
tran_end_time is after ret_do_time
tran_standard is blank or null
tran_standard is Yes but transect was interrupted
tran_standard is Yes but terr_obstacles is not null
tran_standard is Yes but subs_obstacles is not null
tran_standard is Yes but other_obstacles is not null
tran_standard is No with no descriptive information
tran_standard is Yes but unplanned_mod is also Yes
unplanned_mod is Yes with no terrain or substrate obstacles
data_sheet does not match stratum and tran_num concatenation
comments contains special character
comments are blank, should be null
other_obstacles contains special character
total_time_hrs does not match tran_end_time - tran_start_time
tran_num is not suffixed by .9 but type_21 is Yes
tran_standard is Yes but length is less than 10k
non-interrupted shorter than 11,500 m
walk_desc_21 is Std, but substrat_obs_21 is not 12k

Waypoints_21 field checks

tran_num is null
TimeStamp_ is null
stratum is blank or null
wp_num is null
easting is Null
northing is Null
time_ is null
lead and follow are the same
wp_num is 0 but lead and follow are not null
wp_num is 99 but lead and follow are not null
wp_num is 100 but lead and follow are not null
lead or follow is null
crew interrupted transect but lead and follow are not null
waypoint is 0, 1, 99, or 100 but end_tran_part is Yes
waypoint is 0, 1, or 100 but burrow_ct is not null
elev_m is null
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No
manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is blank or null
utm_zone is 11S but easting does not match gps_easting or manual_easting
utm_zone is 11S but northing does not match gps_northing or manual_northing
manual_zone is not Null but manual_easting or manual_northing are Null
utm_zone is 11S but z12 easting and northing fields are not null
utm_zone is 12S but z12 easting or northing fields are null
segment_length is 0 but waypoint is not number 0, 1, 100 or a continuation waypoint
photo_to_wp_xplus1_file does not follow convention
photo_to_wp_xminus1_file does not follow convention
comments contains special character
comments are blank, should be null

OppCarcObs_21 field checks

tran_num is null
TimeStamp_ is null
detection_number is null
stratum is blank or null
easting is Null
northing is Null
elev_m is null
existing_tag is yes, but existing_tag_number or existing_tag_color is null
existing_tag is no, but existing_tag_number and existing_tag_color are not null
carc_condition is blank or null
inconsistency between carc_condition and mcl_mm
mcl_mm is 180 or greater but mcl_greater_180 is not yes
mcl_mm is less than 180 but mcl_greater_180 is not no
sex is blank or Null (should be unknown)
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No
manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is blank or null
utm_zone is 11S but easting does not match gps_easting or manual_easting
utm_zone is 11S but northing does not match gps_northing or manual_northing
manual_zone is not Null but manual_easting or manual_northing are Null
utm_zone is 11S but z12 easting and northing fields are not null
utm_zone is 12S but z12 easting or northing fields are null
photo_carc_file does not follow convention
comments contains special character
comments are blank, should be null

OppLiveObs_21 field checks

tran_num is null
TimeStamp_ is null
detection_number is null
stratum is blank or null
time_ is not within 10 minutes of time from TimeStamp_
time_ is Null
easting is Null
northing is Null
elev_m is null
new_tag_attached is blank or null
new_tag_attached is Yes but new_tag_number is null
new_tag_attached is No but new_tag_number is not null
existing_tag is Yes, but existing_tag_number or existing_tag_color is null
existing_tag is No, but existing_tag_number is not null
inconsistency between existing_tag and new_tag_attached
existing_tag is No and new_tag_attached is null, should be Yes or No
mcl_mm is 180 or greater but mcl_greater_180 is not Yes
mcl_mm is less than 180 but mcl_greater_180 is not No
tort_void is Yes but fluids_offered is not Yes
fluids_offered is Yes but fluids_accepted is not Yes, No Unknown
sex is blank or Null (should be unknown)
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No

manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is blank or null
utm_zone is 11S but easting does not match gps_easting or manual_easting
utm_zone is 11S but northing does not match gps_northing or manual_northing
manual_zone is not Null but manual_easting or manual_northing are Null
utm_zone is 11S but z12 easting and northing fields are not null
utm_zone is 12S but z12 easting or northing fields are null
photo_tort_file does not follow convention
comments contains special character
comments are blank, should be null
tort_location is blank or null
inconsistency between tort_location and mcl_mm
tort_location is not Burrow but burrow_visibility or tort_in_burrow_visibility are not null
tort_location is Burrow but tort_visibility is not null
tort_location is not Burrow but tort_visibility is null
tort_location is Burrow but burrow_visibility or tort_in_burrow_visibility is null
tort_void is blank or null

TranCarcObs_21 field checks

tran_num is null
TimeStamp_ is null
detection_number is null
stratum is blank or null
time_ is not within 10 minutes of time from TimeStamp_
last_wp is null
time_ is null
observer_position is null
observer is null
tran_bearing is null
local_bearing is null
azimuth is null
radial_distance_m is null
perp_distance_m is null
local_bearing is not within 20 degrees of tran_bearing
perp_distance_m is greater than radial_distance_m
radial distance has two decimal places
perp_distance_m does not match calculated perp_distance_m
easting is Null
northing is Null
elev_m is null
existing_tag is Yes, but existing_tag_number or existing_tag_color is null
existing_tag is No, but existing_tag_number and existing_tag_color are not null
carc_condition is blank or null
inconsistency between carc_condition and mcl_mm
mcl_mm is 180 or greater but mcl_greater_180 is not Yes
mcl_mm is less than 180 but mcl_greater_180 is not No
sex is blank or Null (should be unknown)
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No
manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is blank or null
utm_zone is 11S but easting does not match gps_easting or manual_easting
utm_zone is 11S but northing does not match gps_northing or manual_northing

manual_zone is not Null but manual_easting or manual_northing are Null
utm_zone is 11S but z12 easting and northing fields are not null
utm_zone is 12S but z12 easting or northing fields are null
photo_carc_file does not follow convention
comments contains special character
comments are blank, should be null

TranLiveObs_21 field checks

tran_num is null
TimeStamp_ is null
detection_number is null
stratum is blank or null
time_ is not within 10 minutes of time from TimeStamp_
last_wp is null
time_ is null
observer_position is null
observer is null
tran_bearing is null
local_bearing is null
azimuth is null
radial_distance_m is null
perp_distance_m is null
local_bearing is not within 20 degrees of tran_bearing
perp_distance_m is greater than radial_distance_m
radial distance has two decimal places
perp_distance_m does not match calculated perp_distance_m
easting is Null
northing is Null
elev_m is null
new_tag_attached is blank or null
new_tag_attached is Yes but new_tag_number is null
new_tag_attached is No but new_tag_number is not null
existing_tag is Yes, but existing_tag_number or existing_tag_color is null
existing_tag is No, but existing_tag_number and existing_tag_color are not null
inconsistency between existing_tag and new_tag_attached
existing_tag is No and new_tag_attached is null, should be Yes or No
mcl_mm is 180 or greater but mcl_greater_180 is not Yes
mcl_mm is less than 180 but mcl_greater_180 is not No
tort_void is Yes but fluids_offered is not Yes
fluids_offered is Yes but fluids_accepted is not Yes, No Unknown
sex is blank or Null (should be unknown)
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No
manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is blank or null
utm_zone is 11S but easting does not match gps_easting or manual_easting
utm_zone is 11S but northing does not match gps_northing or manual_northing
manual_zone is not Null but manual_easting or manual_northing are Null
utm_zone is 11S but z12 easting and northing fields are not null
utm_zone is 12S but z12 easting or northing fields are null
photo_tort1_file does not follow convention
photo_tort2_file does not follow convention
comments contains special character

comments are blank, should be null
tort_location is blank or null
inconsistency between tort_location and mcl_mm
tort_location is not Burrow but burrow_visibility or tort_in_burrow_visibility are not null
tort_location is Burrow but tort_visibility is not null
tort_location is not Burrow but tort_visibility is null
tort_location is Burrow but burrow_visibility or tort_in_burrow_visibility is null
tort_void is blank or null

Appendix D: 2021 Season G$_0$ Database Final QA/QC Checks

Relationship Checks

From Table	Primary Key	To Table	Foreign Key	Cardinality
G0_Start_21	G0_prime_key	G0_Obs_21	G0_prime_key	1 to Many
G0_Observers_21	observer	G0_Start_21	observer	1 to Many

Range Domain Checks (numeric or date ranges of acceptable values)

Domain	Low value	High value	Table and fields applied to
Start_time	5:00:00 AM	10:00:00 AM	G0_Start_21: start_time
End_time	8:00:00 AM	6:30:00 PM	G0_Start_21: end_time
Time	5:00:00 AM	6:30:00 PM	G0_Obs_21: time_
Date	3/6/2021	5/19/2021	G0_Start_21: date_, TimeStamp_, G0_Obs_21: date_, TimeStamp_
Easting	408849	794114	G0_Obs_21: easting
Northing	3648506	4133135	G0_Obs_21: northing
Elevation	0	1800	G0_Obs_21: elev_m

Coded Value Domain Checks (lists of acceptable values)

Domain	Values	Table and fields applied to
G0_site	'CK','HW','OR','IV','GB','PM'	G0_Start_21: G0_site, G0_Obs_21: G0_site
Group	'Kiva','GBI'	G0_Start_21: group_, G0_Obs_21: group_
Yes_No	'No', 'Yes'	G0_Obs_21: visible, gps_grab_success
Behavior	'Agonistic', 'Basking', 'Digging', 'Eating', 'Moving', 'at Rest-active', 'Mating', 'Unknown'	G0_Obs_21: behavior
Tort_location	'Open', 'Pallet', 'Rock', 'RockBurrow', 'SoilBurrow', 'Vegetation'	G0_Obs_21: tort_location
High_Med_Low	'High', 'Medium', 'Low', 'NotVisible'	G0_Obs_21: burrow_visibility, tort_in_burrow_visibility, tort_visibility

Duplicate Checks

Table	Check
G0_Start_21	contains duplicate G0_prime_key values
G0_Start_21	contains duplicate G0_site, date_, observer
G0_Obs_21	contains duplicate G0_obs_key values
G0_Obs_21	contains duplicate G0_site, date_, time_, tort_num

SQL checks (involves multiple tables)

Table	Check
G0_Obs_21	observation G0_site does not match start G0_site
G0_Obs_21	observation date_ does not match start date_
G0_Start_21	observer and group do not match observer and group in the

	G0_Observers_21 table
G0_Start_21	group_ does not match group_ in the G0_SiteInfo_21 table
G0_Obs_21	group_ does not match group_ in the G0_Start_21 table
G0_Obs_21	G0_site and tort_num do not match G0_site and tort_num in the G0_TortInfo_21 table
G0_Start_21	G0 start does not have any associated observations
G0_Obs_21	observation does not have an associated G0 start
G0_Start_21	G0 start does not have an associated observer in the observers table
G0_Start_21	comments field contains a carriage return
G0_Obs_21	comments field contains a carriage return
G0_Obs_21	time is before or after start_time and end_time, +-30 minutes

G0_Start_21 field checks

 G0_site is blank or null
 G0_prime_key is blank or null
 TimeStamp_ is null
 TimeStamp_ year is out of range
 date_ does not match date from TimeStamp_
 UserName is blank or null
 date is null
 group_ is blank or null
 observer is blank or null
 start_time is null
 end_time is null
 group_ is Kiva and date is before 3/6/2021 or after 5/19/2021
 group_ is GBI and date is before 3/12/2021 or after 5/19/2021
 start_time is after end_time
 datasheet does not follow convention
 photo1_file does not follow naming convention
 photo2_file does not follow naming convention
 photo3_file does not follow naming convention
 photo4_file does not follow naming convention
 comments contain special character
 comments are blank, should be null

G0_Obs_21 field checks

G0_site is blank or null
G0_prime_key is blank or null
TimeStamp_ is null
UserName is blank or null
date is null
TimeStamp_ year is out of range
date_ does not match date from TimeStamp_
G0_obs_key is blank or null
tort_num is null
time_ is null
easting is Null
northing is Null
gps_bluetooth is null but gps_grab_success is not No
manual_easting or manual_northing are null and gps_grab_success is No
manual_easting or manual_northing are not null and gps_grab_success is Yes
utm_zone is 11 but easting does not match gps_easting or manual_easting
utm_zone is 11 but northing does not match gps_northing or manual_northing
elev_m is null

visible is blank or null
tort_location is blank or null
behavior is blank or null
inconsistency between visibility and behavior
visible is No, but tort_location is not Burrow, Vegetation or Pallet
visible is No, but tort_visibility is not NotVisible
visible is Not but burrow_visibility is not null or tort_in_burrow_visibility is not null or tort_visibility is not Not Visible
tort_location is not Burrow but burrow_visibility or tort_in_burrow_visibility are not null
tort_location is Burrow but tort_visibility is not null
tort_location is not Burrow but tort_visibility is null
tort_location is Burrow but burrow_visibility or tort_in_burrow_visibility is null
tech recorded location as burrow, but tort was not in burrow when located
easting is not within range for the G0_site
northing is not within range for the G0_site
comments contain special character
comments are blank, should be null