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Forecasting Climate-Induced Ecosystem Changes on Army Installations

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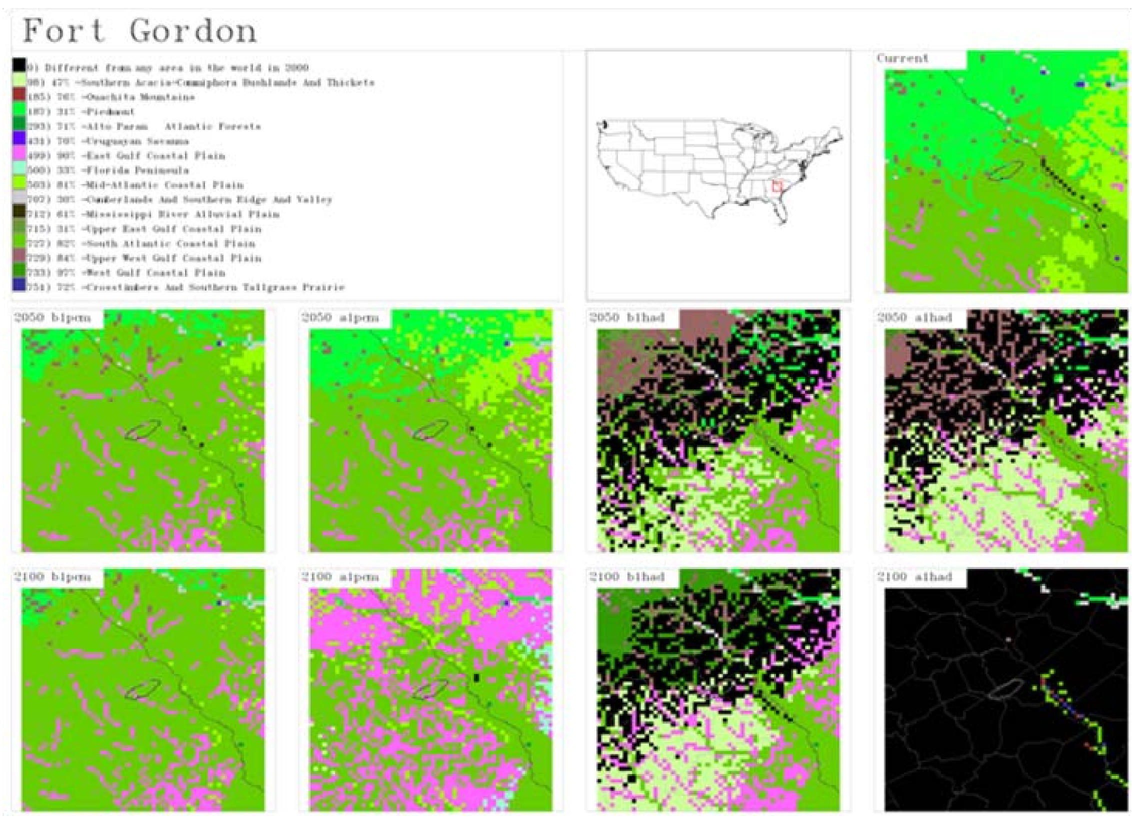
October 2011



Construction Engineering
Research Laboratory

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Abstract

Military installation training lands must be managed to support species at risk as well as to be effective training environments for soldiers. Forecasts from various global climate change models suggest that the habitats associated with some military training installations will face pressures that induce biome-shifts, invasive species, loss of habitat, and changes in training opportunities. This study combined worldwide habitat forecast data with a current habitat map to identify major installations that appear to be most and least at-risk for habitat change.

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Preface

This study was conducted for Dr. Jeffrey Holland, Director of the Engineer Research and Development Center under a project called, "Integrated Risk Management for Climate Change," via the Center Directed Research Program. The project Principal Investigator was Dr. Todd Bridges of the Environmental Laboratory.

The work was performed by the Environmental Processes Branch (CN-N) of the Facilities Division (CF), Construction Engineering Research Laboratory (CERL). The CERL Principal Investigator was Dr. James Westervelt. William Meyer is Chief, CEERD-CN-N, and Dr. John Bandy is Chief, CEERD-CF. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the US Army Engineer Research and Development Center (ERDC), US Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Kevin J. Wilson, and the Director of ERDC is Dr. Jeffery P. Holland.

1 Introduction

1.1 Background

Military installations and ranges support military training and testing across the United States. That land must be managed in a manner that ensures that the military continues to have excellent conditions to support the training and testing missions. An emerging potential threat to those conditions comes in the form of forecasted climate change, which might directly affect training by changing erosion challenges or by compromising training realism. Climate change may also indirectly affect training by changing the suitability of on-installation important habitats – including areas that support threatened or endangered species.

1.2 Objective

This objective of this work was to address three questions regarding the anticipated implications of forecast climate change in the Continental United States (CONUS):

- Which Army installations are most at-risk with respect to ecosystem changes?
- What is the range of anticipated ecosystem shifts based on the forecasts of general circulation models (GCMs)?
- Where can one go today to find the ecosystem drivers (weather, climate, soil, and sun) anticipated in the future?

1.3 Approach

This study assumed that ecosystems are driven by conditions involving temperature, rainfall, solar insolation, and soil characteristics. By correlating these conditions with the ecosystems found across the United States (and the globe), it is possible to forecast ecosystem shifts based on forecast changes to these conditions. Note that identifying shifts in conditions that might favor a different ecosystem is only the first step in actually forecasting the timing or speed with which any given area will shift. Ecosystems can be associated with a significant level of persistence and it can take decades or even millennia for seeds to establish themselves in distant areas.

1.4 Scope

This study focused primarily on major CONUS Army installations.

1.5 Mode of technology transfer

This report will be made accessible through the World Wide Web (WWW) at URL: http://www.cecer.army.mil

2 Analysis Steps

This study developed future habitat maps for the Continental United States based on forecasts from global climate change models and habitat classifications developed by the Gap Analysis Program (GAP). Developing future habitat maps involves five steps (Figure 1). Three subsequent analyses use these maps: (1) installation biome shift analysis, (2) an analysis to find current areas that represent forecast installation conditions, and (3) an analysis to rank installations by degree of ecosystem driver shifts. The following sections describe each of the steps taken to develop these future habitat maps.

2.1 Steps 1 & 2: Climate Modeling

These efforts began with published data sets of current and future climate information created for the entire globe by the WorldClim group (http://www.worldclim.org). The climate modeling data development and analysis story begins with the running of General Circulations Models (GCM). The Intergovernmental Panel on Climate Change (IPCC), co-sponsored by the United Nations Environmental Programme (UNEP) and the World Meteorological Organization (WMO), is a focal point for coordinated global climate change analyses. In 2001, IPCC published the "Third Assessment Report" in four volumes. The first volume provides the scientific basis of the climate change analyses (IPCC 2001). From the IPCC 2001 analysis, results from two global climate models (GCMs, also known as general circulation models) were selected to represent forecast change extremes. The Hadley Centre model, HadCM3 (Wood et al. 1999), provides the conservative bookend. The National Center for Atmospheric Research (NCAR) Parallel Climate Model (PCM; Dai et al. 2001a; Hu et al. 2004) provides the more extreme forecasts.

These model the globe using grid cells that are roughly 3-degrees square. The Hadley model links an Ocean Model (HadOM3), which includes sea ice; with an atmospheric model (HadAM3). The PCM fully couples an 18-level atmospheric general circulation model (GCM), the 32 level Los Alamos National Laboratory Parallel Ocean Program (POP; Smith et al. 1992; Dukowicz and Smith 1994) ocean GCM, a land surface model, and a dynamic–thermodynamic sea ice model (Washington et al. 2000).

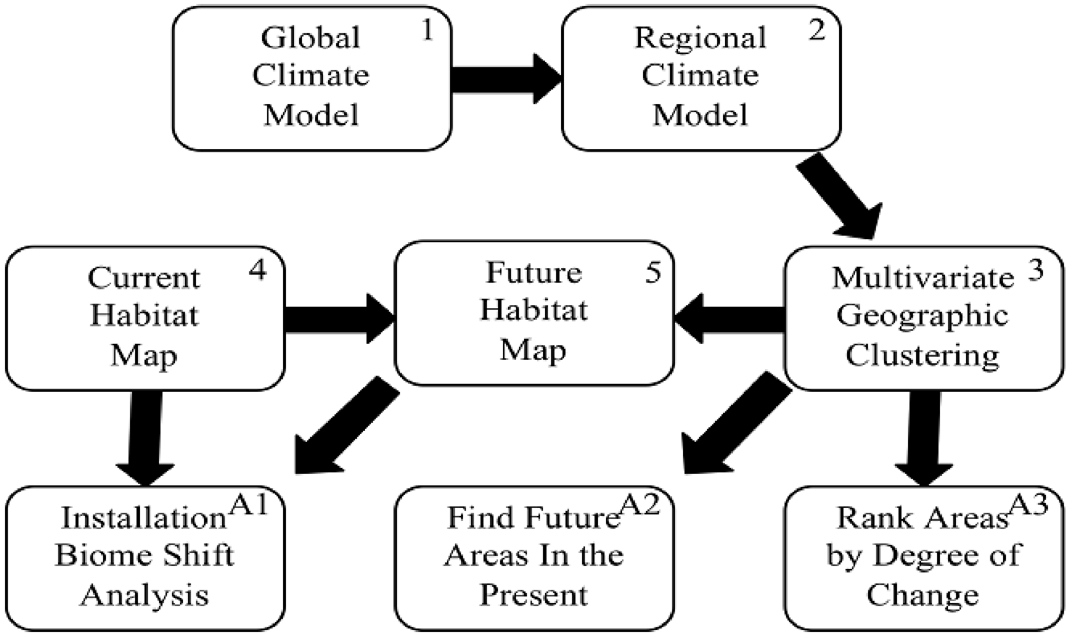


Figure 1. Overall approach.

These models were run using two internationally standardized gas-emission scenarios: Scenario A1, ("business-as-usual"), which corresponds with the highest emissions; and Scenario B1, which corresponds with the lowest emissions. Climate states for 2050 and 2080 were captured for downscaling.

The GCM data were processed into global climate layers by the WorldClim group posted at the WorldClim website (http://www.worldclim.org). The WorldClim group specializes in the development of ~1-km resolution climate maps for the world using thin-plate spline interpolations of worldwide weather station data (Hijmans et al. 2005). To create future maps at this resolution, GCM outputs (typically at resolutions of about 110 km) were compared with current conditions to create difference maps (of temperature and rainfall by season). These maps, in turn, were interpolated to the 1-km resolution and added to the equivalent WorldClim current weather maps (see: http://www.worldclim.org/downscaling). Using this approach, the WorldClim has processed 2020, 2050, and 2080 outputs from three GCM models that each ran A2A and B2B scenarios, for the third IPCC assessment report (TAR). For each model, scenario, and date combination, WorldClim generated monthly averages for maximum temperature, minimum temperature, and precipitation.

Using the WorldClim results, Chris Zganjar, of The Nature Conservancy, developed and ran geographic information processing scripts to generate nine maps that represent current conditions and future conditions (2050 and 2080) for two scenarios run by two GCMs. The resulting maps represent the current global system and the combinations of the two models, two scenarios, and 2 future years:

1. Precipitation during the locally hottest quarter
1. Precipitation during the locally coldest quarter
2. Precipitation during the locally driest quarter
3. Precipitation during the locally wettest quarter
4. Ratio of precipitation to potential evapotranspiration
5. Temperature during the coldest local quarter
6. Temperature during the hottest local quarter
7. Sum of local monthly Tavg where Tavg >=5 °C
8. Integer number of consecutive months where Tavg >= 5 °C (Length of potential growing season).

2.2 Step 3: Multivariate geographic clustering

Hargrove and Hoffman (2005) reviewed the history of statistical and geographic information system (GIS) based ecosystem map development and then described their Multivariate Geographic Clustering (MGC) empirical process for identifying habitats. They used nine characteristics captured as maps for the conterminous United States:

1. Plant-available water capacity
9. Soil organic matter
10. Total Kjeldahl soil nitrogen
11. Depth to a seasonally high water table
12. Mean precipitation during the growing season
13. Mean insolation during the growing season
14. Degree-day heat sum during the growing season
15. Degree-day cold sum during the non-growing season
16. Elevation.

Maps were at a resolution of 1-km. Each of the maps was converted to non-dimensional forms by assigning standard-deviation values from the means of each of the maps values. This resulted in each location being characterized by a coordinate point in the 9 dimensions. Hargrove and Hoffman used a two-step process using clustering and classification to classify all locations. In the first step, the 9-dimensional space was divided in up to 3000 cluster centers that were then moved around the space until each cluster signature was associated with a similar number of locations (a subset of 1-km cells). With the established cluster means, each location was then assigned to the cluster that has the closest Euclidian distance in the 9-dimensions.

This study applied the MGC procedure simultaneously using nine sets of 16 map layers representing the current global state and the eight forecast future states:

1. Precipitation during the locally hottest quarter
17. Precipitation during the locally coldest quarter
18. Precipitation during the locally driest quarter
19. Precipitation during the locally wettest quarter
20. Ratio of precipitation to potential evapotranspiration
21. Temperature during the coldest locally quarter
22. Temperature during the hottest locally quarter
23. Sum of monthly Tavg where Tavg >=5 °C
24. Integer number of consecutive months where Tavg >= 5 °C (Length of potential growing season)
25. Available water holding capacity of soil
26. Bulk density of soil
27. Carbon content of soil
28. Nitrogen content of soil
29. Compound topographic index (relative wetness)
30. Solar interception
31. Day/night diurnal temperature difference.

To facilitate the combination and comparison of these maps through a cluster analysis, each was transformed by calculating the standard deviation of the maps' values. This resulted in a 16-value signature for every one of 48.6 million 2-minute square cells for the globe (including water areas) between 60 degrees south latitude and 90 degrees north latitude (10,800 columns and 4500 rows). The signatures for all land areas and for all maps were then clustered into 30,000 clusters. This large number of clusters allows for relatively fine separation of habitat types, yielding an average of about 500 cells per cluster. Figure 2 shows the resulting map for the area of the United States based on current (2000) conditions.

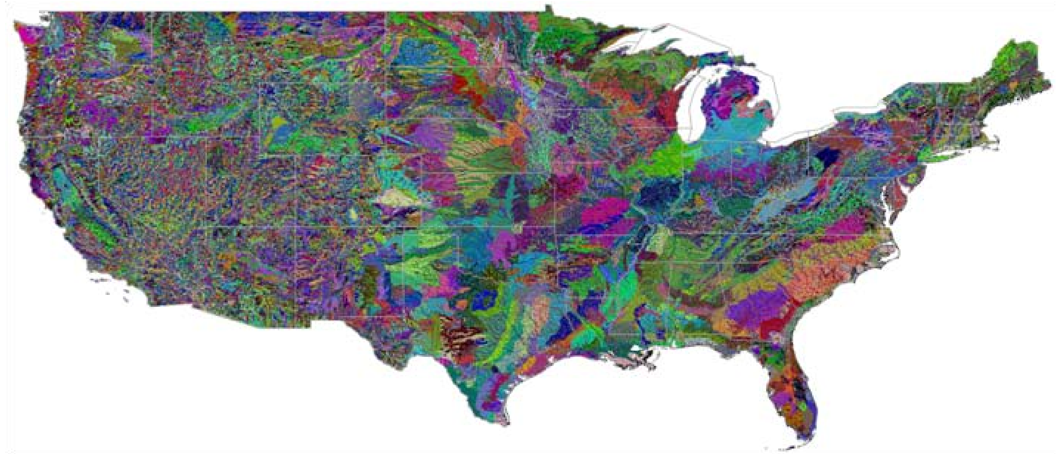


Figure 2. Global ecosystem map — random color table.

The color table is random and shows areas that are similar in the combination of the conditions represented in the 16 input maps. Note that analysis was done for the entire globe and for the eight future condition combinations. This means that areas with the same set of conditions anywhere in the world and/or any time in the future are assigned the same cluster number. The averages of the conditions for all locations associated with a cluster results in a signature for that cluster. This results in an extremely powerful set of maps that can be used for answering a wide variety of questions. Any naturally occurring thing on the earth can be located in the current map to identify the associated clusters and signatures, which can be located across the earth, currently and in the future.

For example, by identifying the location of oak-hickory assemblages, one can then identify the gridcells associated with those areas and find out what clusters they represent. By highlighting the gridcells across the country (or globe) across the future conditions, it is possible to identify where the conditions are forecast to be found that are currently associated with oak-hickory forests. This procedure can be used for locating the future locations of areas that share the ecosystem drivers currently associated with habitat, species, growing areas, cities, forests, or military installations.

2.3 Step 4: Current habitat maps

The 30,000 cluster categories generated for the globe across the current and nine future scenarios are simply statistically-similar areas based on standard-deviation values representing 16 distinct soil characteristics, solar interception, and climate values. Correlating these clusters with accepted habitat types is relevant to this work. This begins with selecting a habitat classification. Many habitat classification maps have been developed for the United States. Early examples include the Bailey (1983, 1995, 1996) and Omernick (1987) classification maps. Bailey generated maps at three levels of detail, identifying 52 ecoregions at the finest level. For studying water resources, Omernick identified 76 national ecoregions. These maps were created through a combination of computer-assisted classification of mapped data and subjective expert opinion.

This study selected two modern ecosystem classifications. The first, the GAP national land cover map, was developed by the GAP program (Davidson, 2010) and uses the Ecological System classification system developed by NatureServe to represent natural and semi-natural land cover, and covers the continental United States.

> Ecological systems were developed as a means of representing recurring groups of biological communities that are found in similar physical environments and that are influenced by similar dynamic ecological processes, such as fire or flooding. In addition, the national map contains 551 Ecological Systems and modified Ecological Systems containing 39 land use classes, which are depicted developed and disturbed land cover classes (GAP 2011).

Figure 3 shows the GAP map for the United States. Note that Appendix A to this report (Figure A1,p 34) contains the legend for this map (and all maps derived from this GAP map).

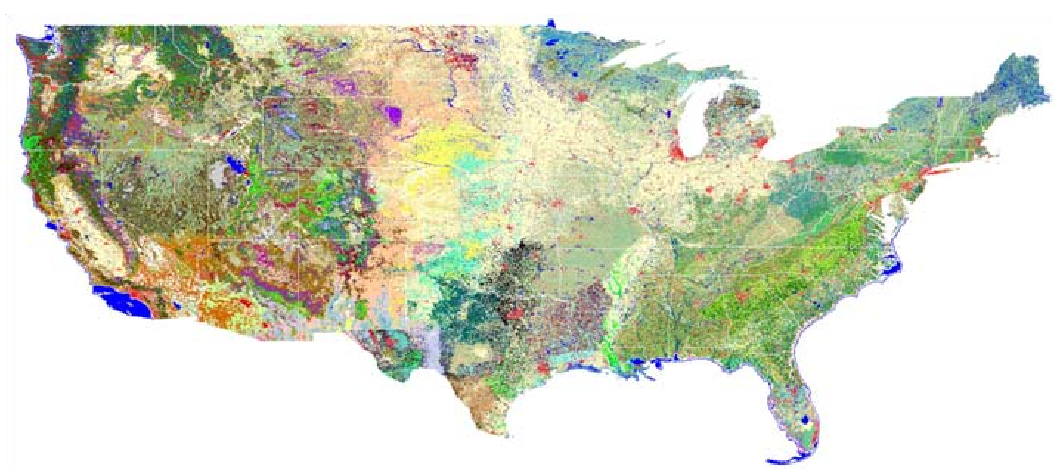


Figure 3. GAP national land cover map.

The second ecosystem map adopted covers the globe and was developed by the Nature Conservancy (TNC) as a unified global representation of ecosystems. Figure 4 shows the global TNC map* and Figure 5 shows the corresponding CONUS map. Figure A2 (p 35) contains the legend for the TNC maps. Note that the GAP ecosystem map is much more detailed than the TNC map (688 categories across the globe, but only 70 across CONUS).

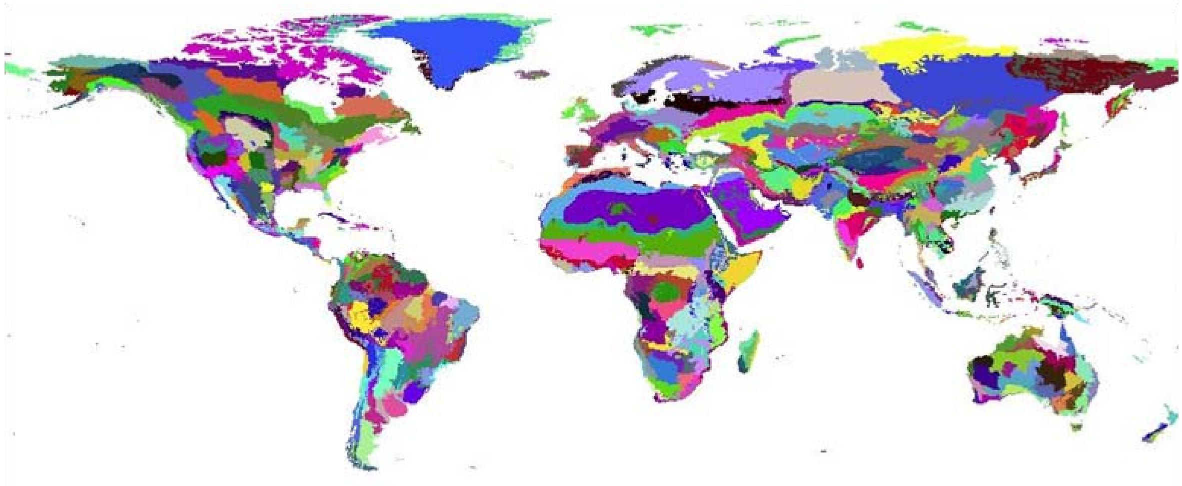


Figure 4. TNC ecosystems of the world.

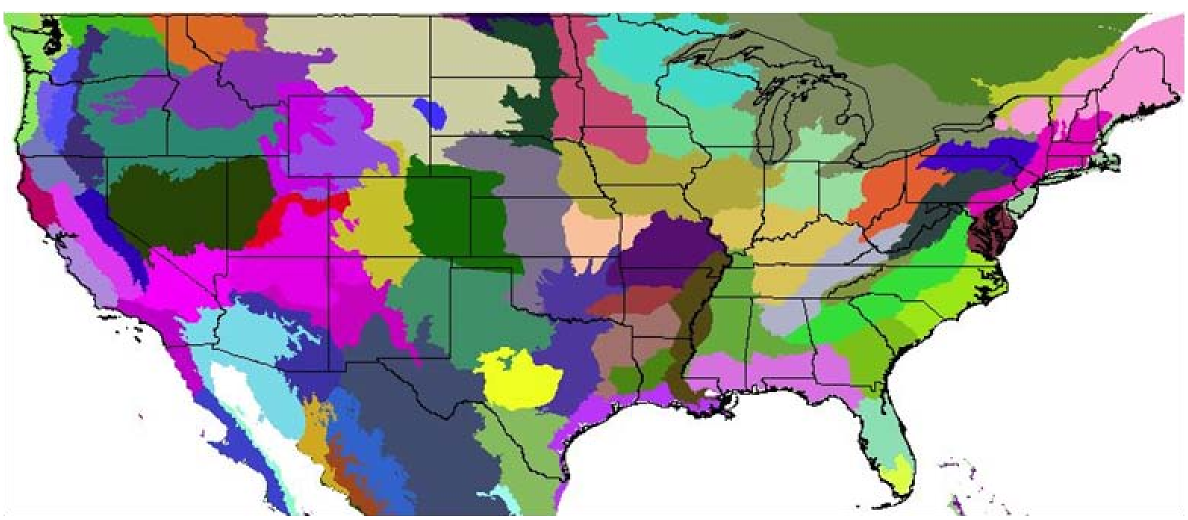


Figure 5. TNC ecosystems of the world — United States.

* Also available through URL: http://www.nature.org/multimedia/maps/

2.4 Step 5: Future habitat map

The goal of this step was to generate a consistent set of one current and eight future habitat maps based on the 551 GAP ecosystem and land use classes for CONUS and the 688 TNC ecosystem classes for the world. These are based on all combinations of two GCM models (Hadley and PCM), two scenarios (A1 and B1 emission levels), and two future times: 2050 and 2080. This step begins with eight future maps (and a current map) that have been collectively classified into 30,000 habitat clusters (Step 3). That is, each of the nine maps shares the same cluster values. Therefore, if the cluster categories in any one of the maps can be associated with ecosystems, then that same association can be shared with the other eight maps. This was done by cross-referencing the 551 GAP ecosystem and land use classes (Figure 3) with the cluster categories (Figure 2) (4284 categories of the 30,000 across the world, across the nine maps) found in the conterminous current map. Counts were made of the number of cells sharing each GAP category with the various cluster categories. For each cluster category, a count of the number of cells containing each shared GAP category was established and the most commonly shared GAP category was then assigned to each respective cluster category.

The reassignment relating Figure 2 to Figure 3 resulted in the map shown in Figure **6**. The 4284 cluster categories mapped into 243 (less than half) of the 551 GAP categories. Many GAP categories that represented small areas were washed out in the process – leaving only the more dominant ecosystem types. The cross-referencing established for the current map was then applied to all of the future maps – providing the basis for forecasting ecosystem change.

The same procedure was followed with the global TNC map. Each of the clusters was associated with the one TNC ecosystem type that most frequently correlated with the cluster. Unlike the GAP-based analysis, this was done with the global map. Figure 7 shows the result for CONUS.

There are two interesting differences between Figure 7 and Figure 5. First, the number of ecosystem categories across the United States increased from 70 to 287. This is because the entire globe was analyzed simultaneously and there are many cases where small areas in CONUS share the ecosystem driver conditions associated with broader areas elsewhere.

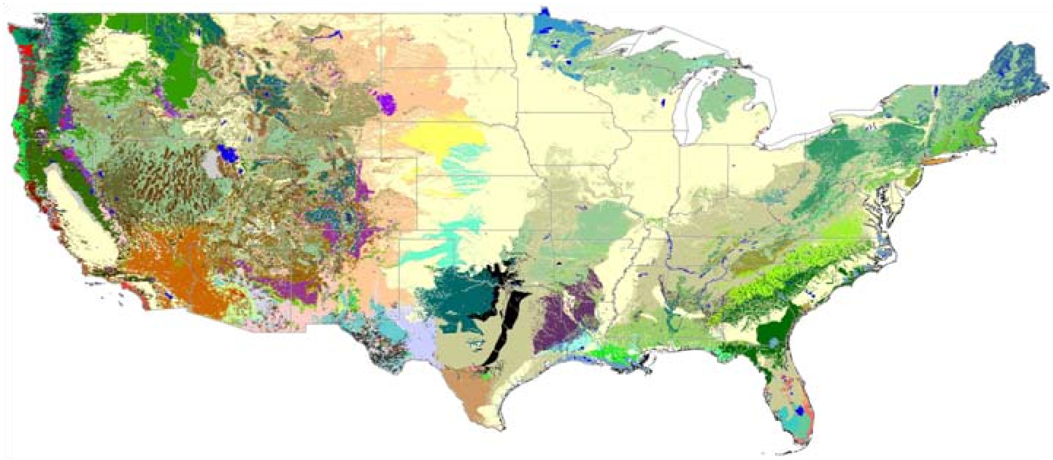


Figure 6. Global ecosystem map reclassified to GAP categories.

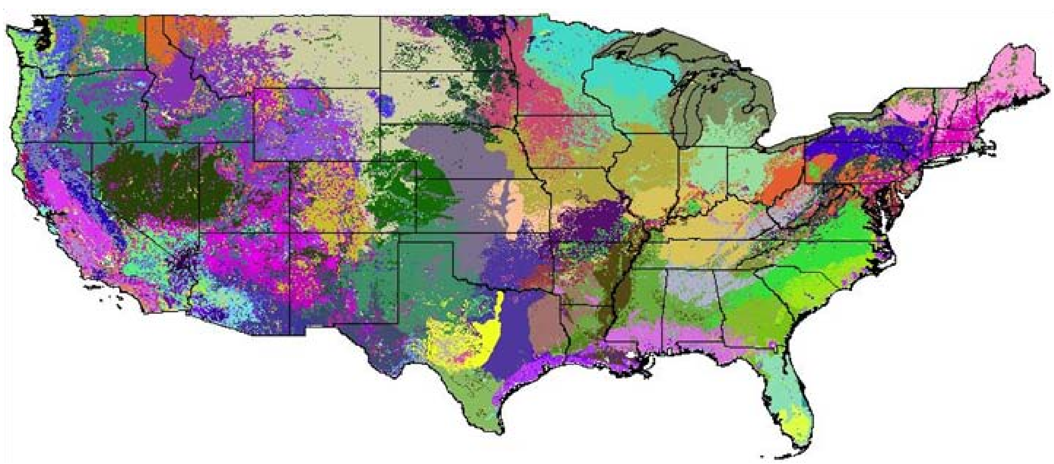


Figure 7. Global ecosystem map reclassified to TNC categories.

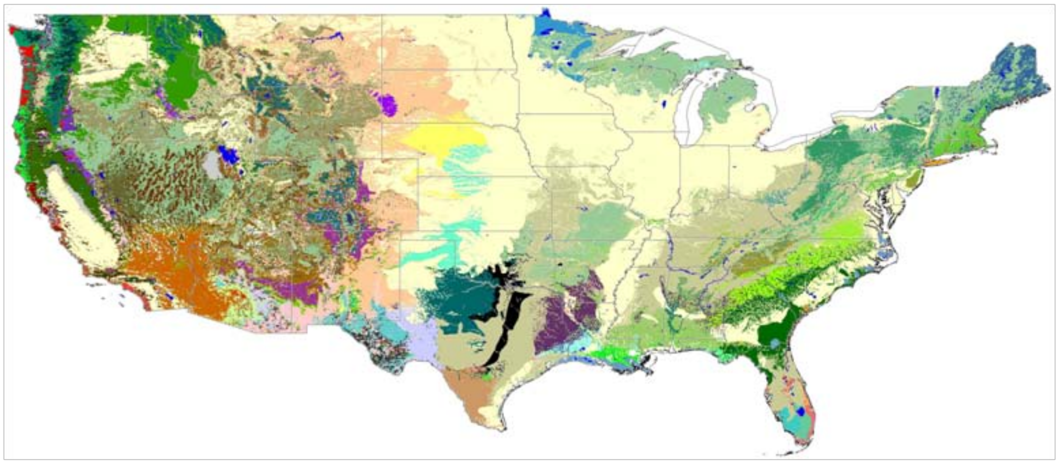
In many cases, these areas in CONUS can be very small. Second, while the ecosystem areas are grossly located similarly across the states, the edges of the ecosystem areas are much more jagged in the new map (Figure 7), more accurately representing reality in nature, and its lack of solid edges.

The new GAP and TNC maps were generated using lookup tables that associate each cluster to the associated ecosystem type. By applying these two lookup tables to the eight future maps, it is possible to generate sets of GAP and TNC-based ecosystem maps.

Future time series for each of the two models and the two emission time series are displayed for the GAP-based series in Figures 8 to 11; and for the TNC-based series in Figures 12 to 15. These are in order of apparent ecosystem impact severity. The PCM B1 scenario results are captured in Figures 8 and 12. The top image in each shows the current system state, the center image shows the scenario projected for 2050, and the bottom image, the scenario projected for 2080. This pattern is repeated in Figures 13 to 15. Significant shifts are evident in even the least dramatic forecast of change. Note, for example, the northern shifts in northern Texas and into Oklahoma. Northward shifts are also easily apparent in the Appalachian ecosystems.

The A1 scenario PCM model results (Figures 9 and 11) show similar, but more dramatic, changes. Note the changes throughout most of the country. Note the white areas throughout the 2080 map. Most of these areas represent changes that have no current United States ecosystem analogs. In some cases, these can be mapped to existing areas elsewhere in the world. In other cases there are no current world analogs.

The B1 and A1 Hadley results follow in Figures 10 and 11 (and Figures 14 and 15) respectively. The B1 forecast is more severe than the PCM A1 results. The A1 results suggest extremely dramatic changes throughout most of the country.



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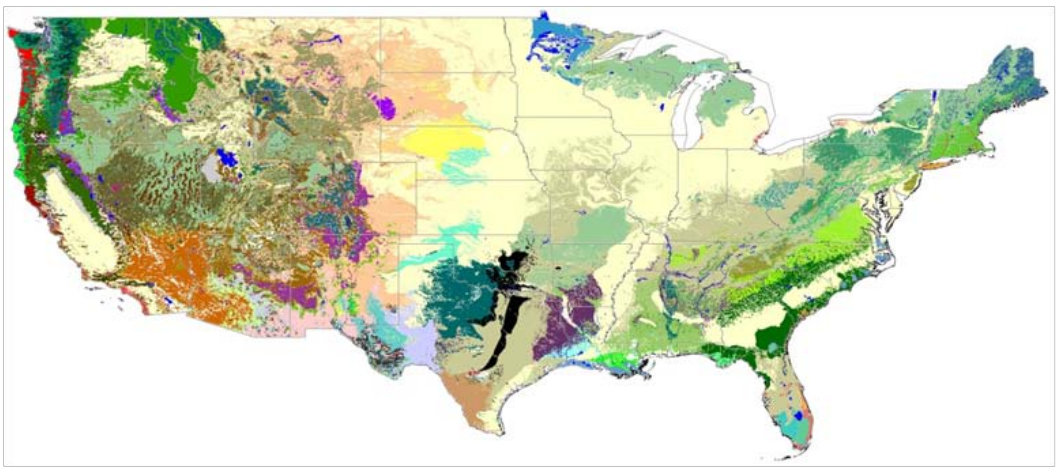
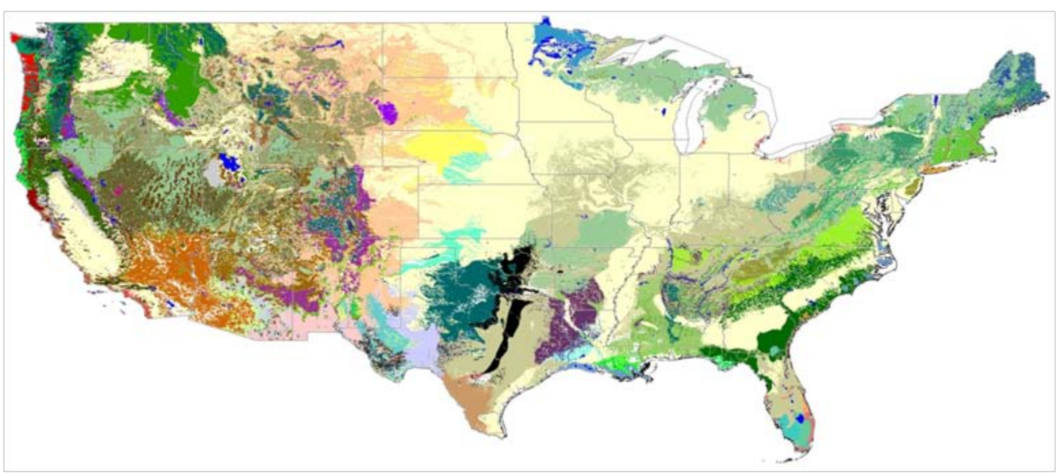
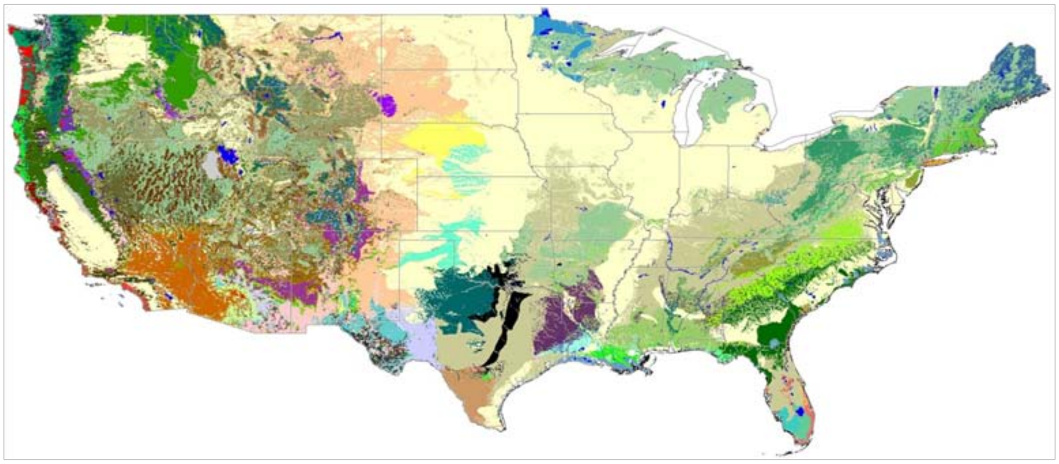


2050

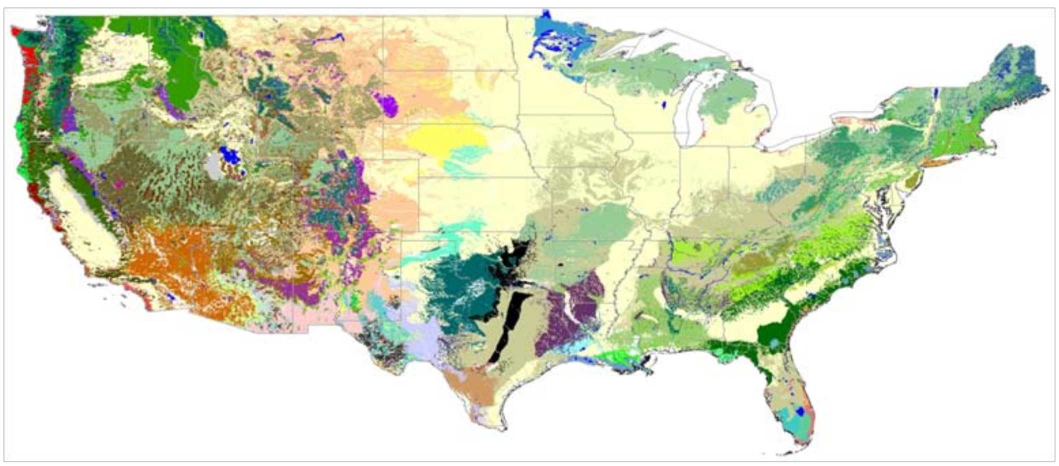


2080

Figure 8. B1 Scenario, PCM Model; GAP Categories.



Current



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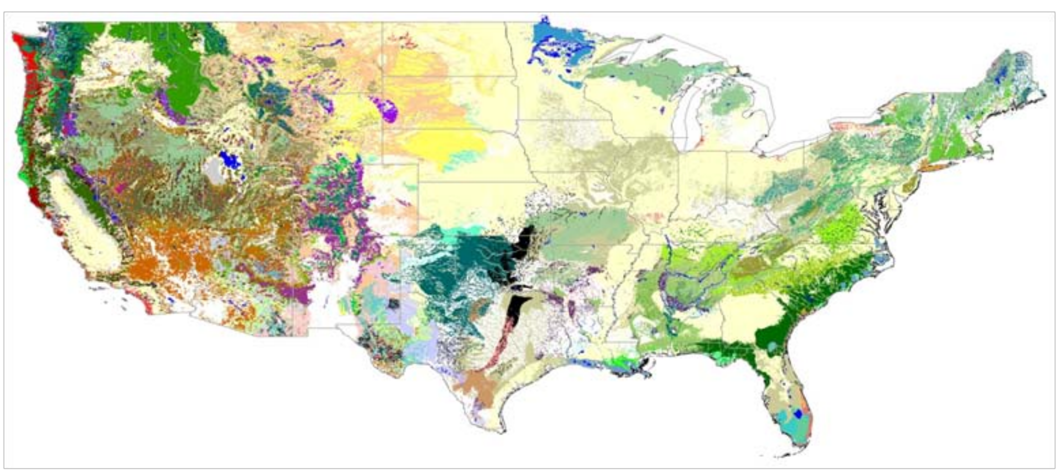
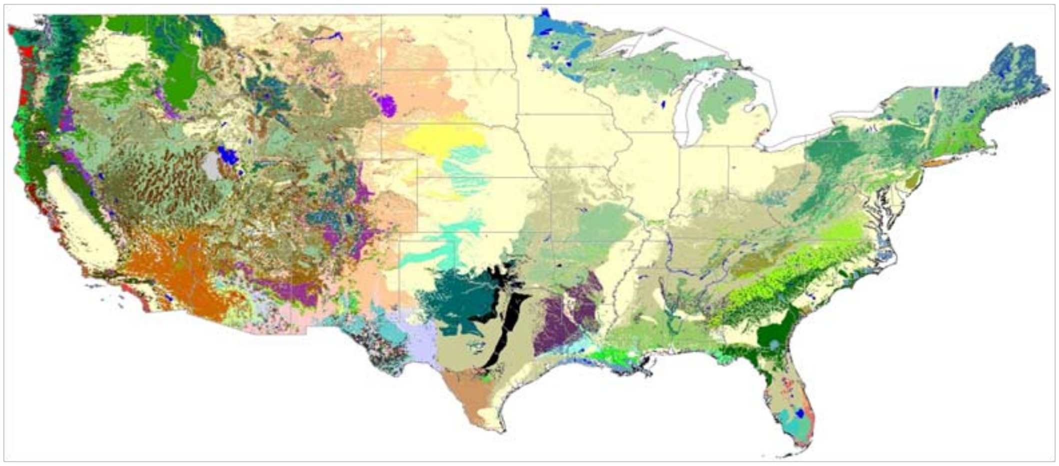


2080

Figure 9. A1 Scenario, PCM Model; GAP categories.



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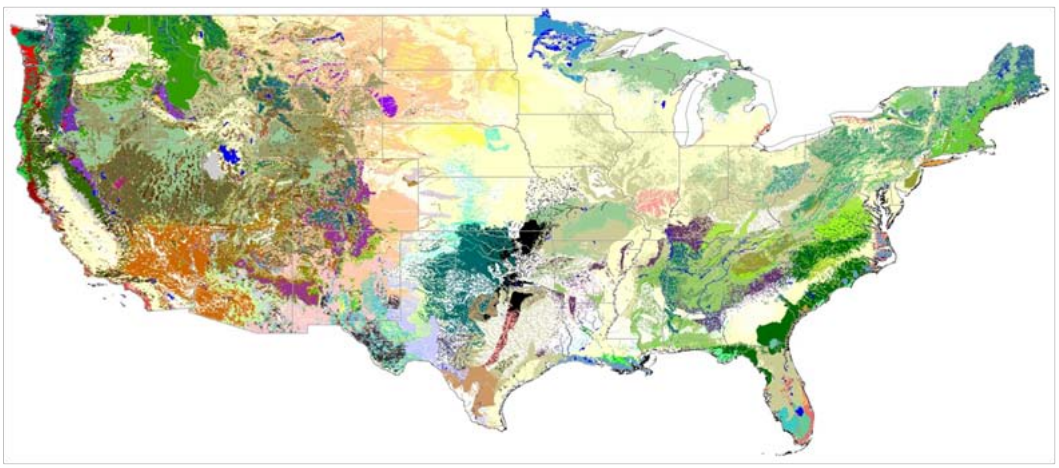
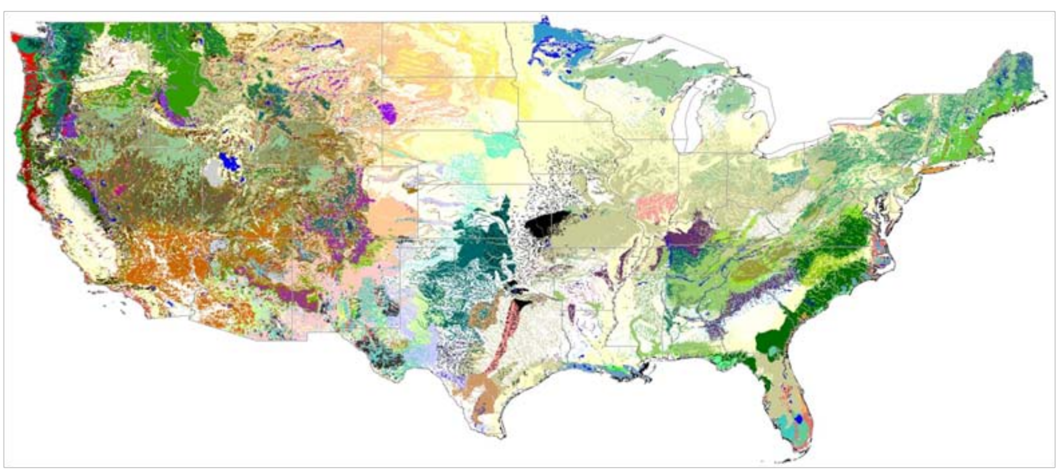
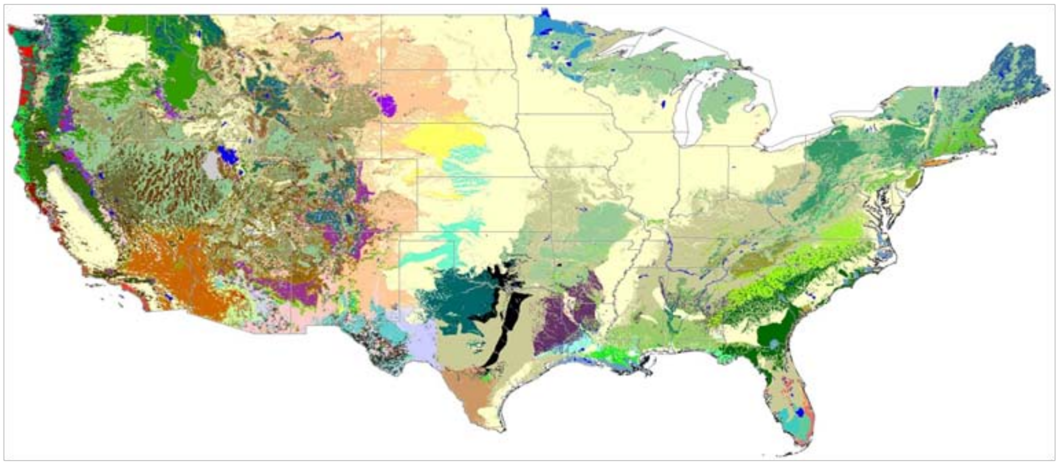


2050



2080

Figure 10. B1 Scenario, HAD Model; GAP categories.



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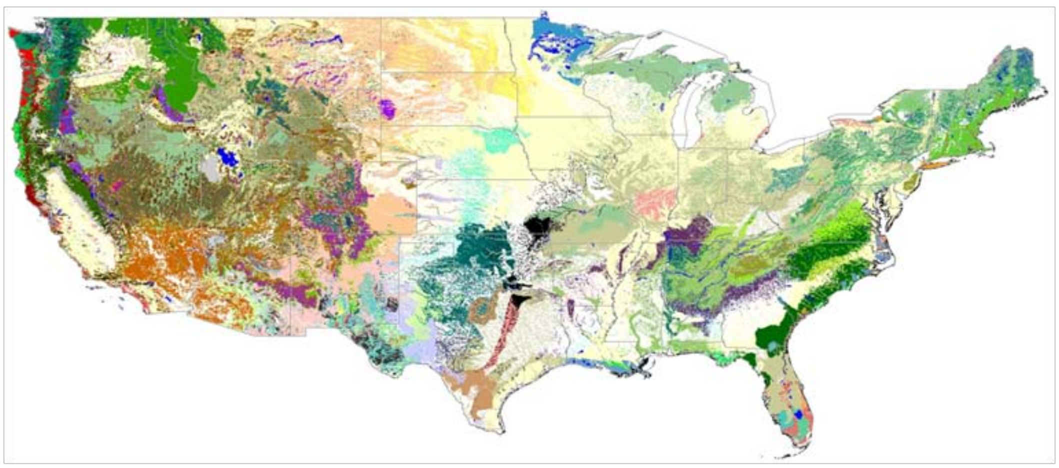

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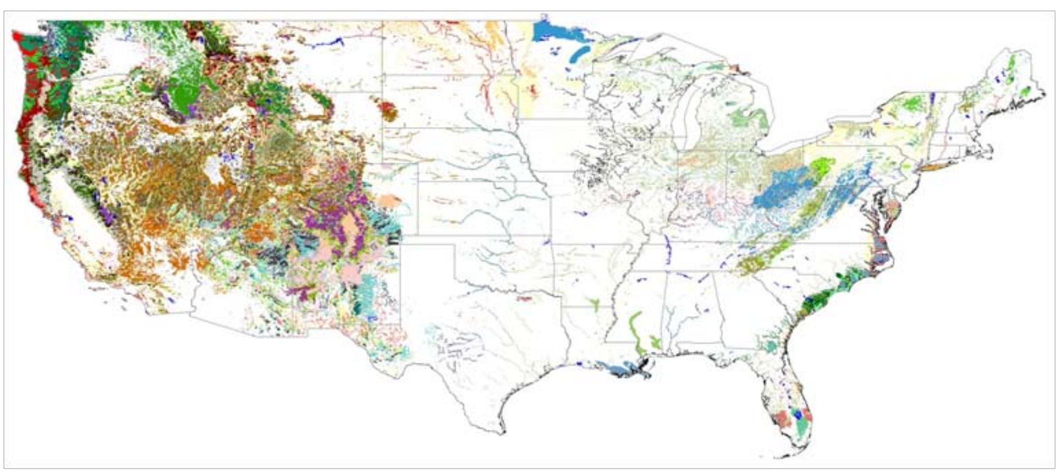


2080

Figure 11. A1 Scenario, HAD Model; GAP categories.

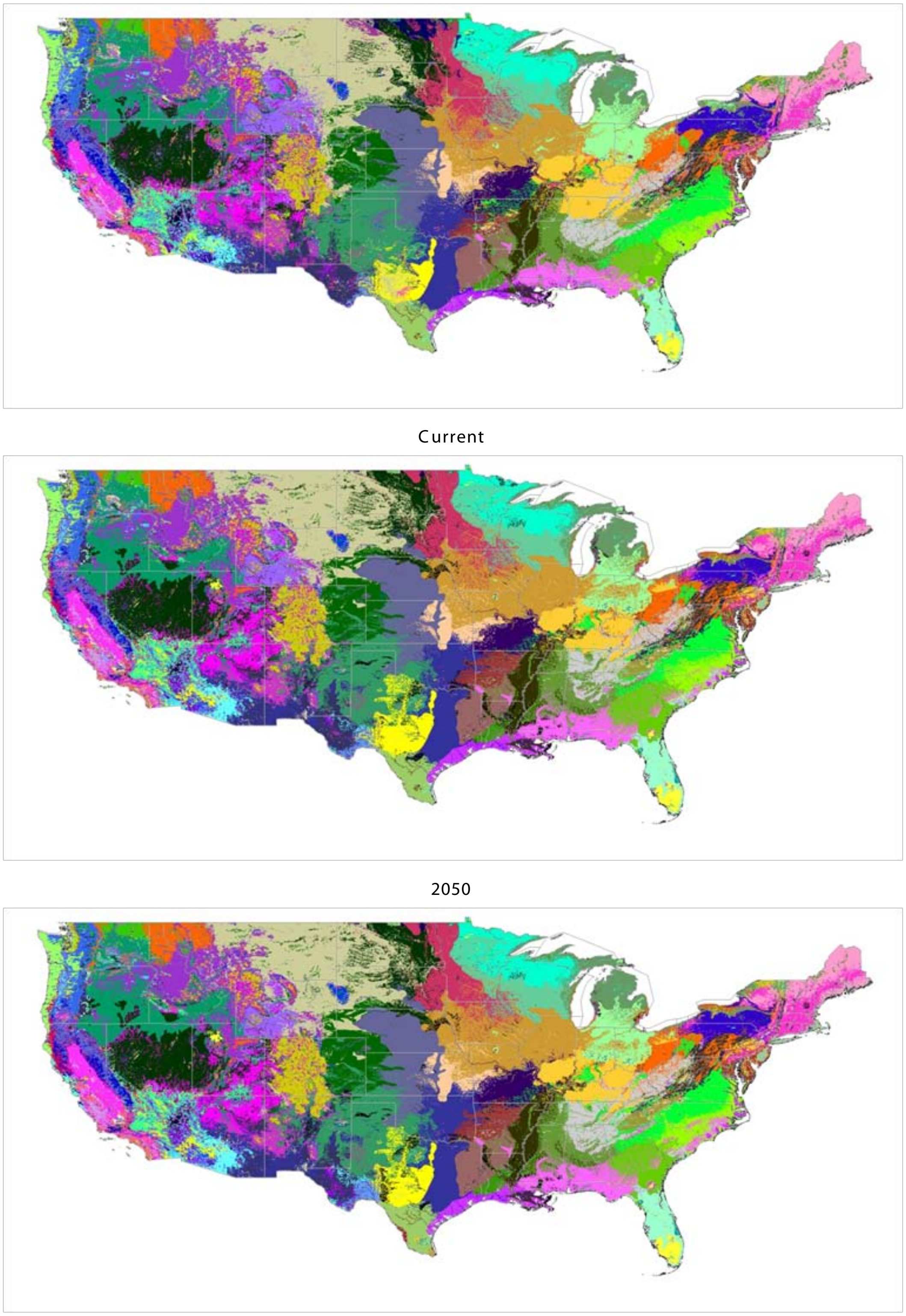
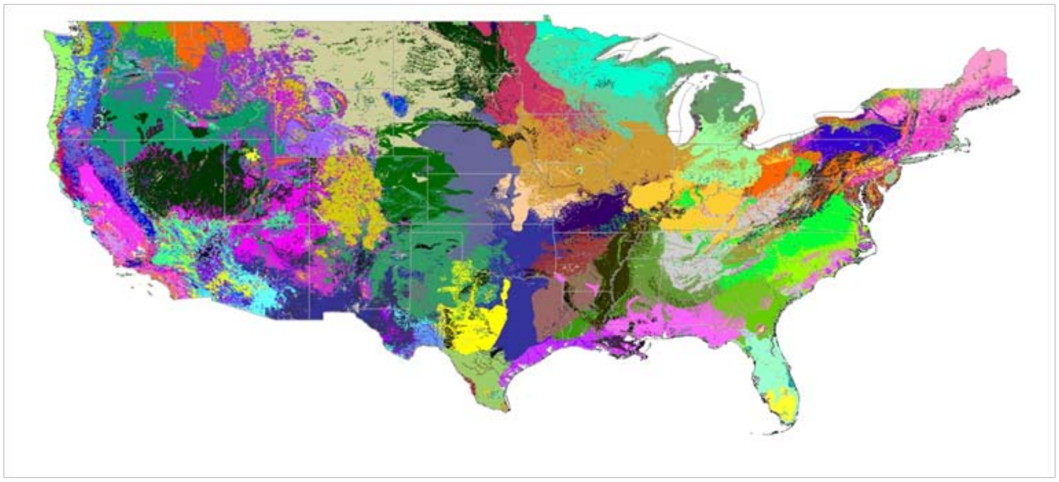
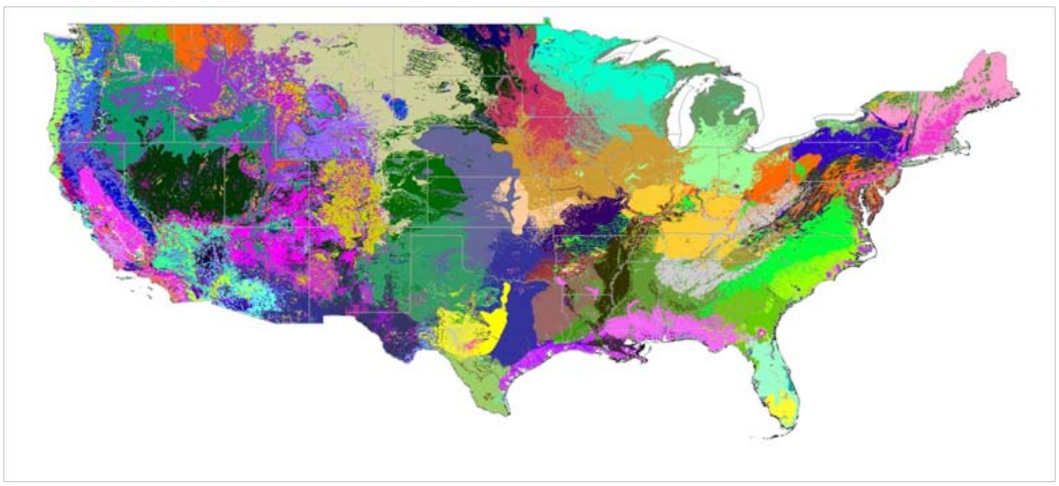


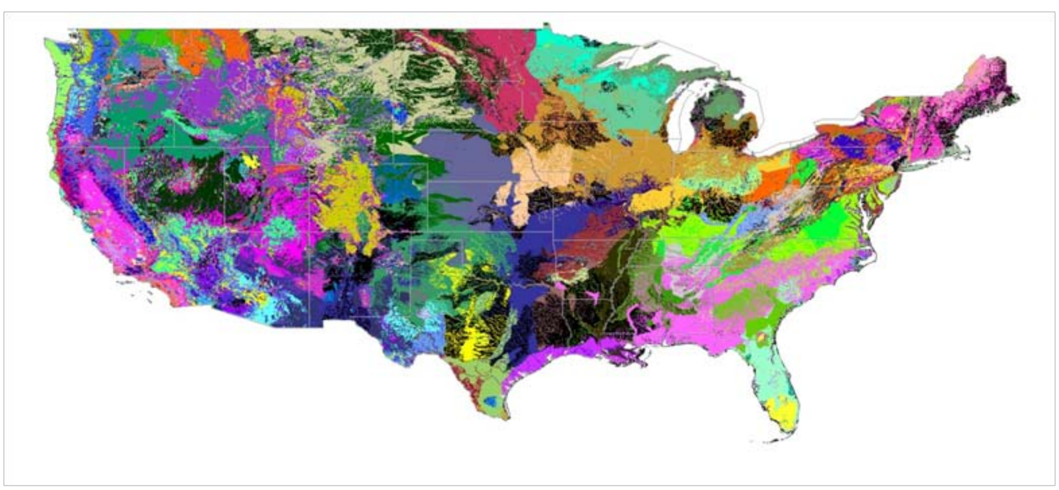
Figure 12. B1 Scenario, PCM Model; TNC categories.



Current

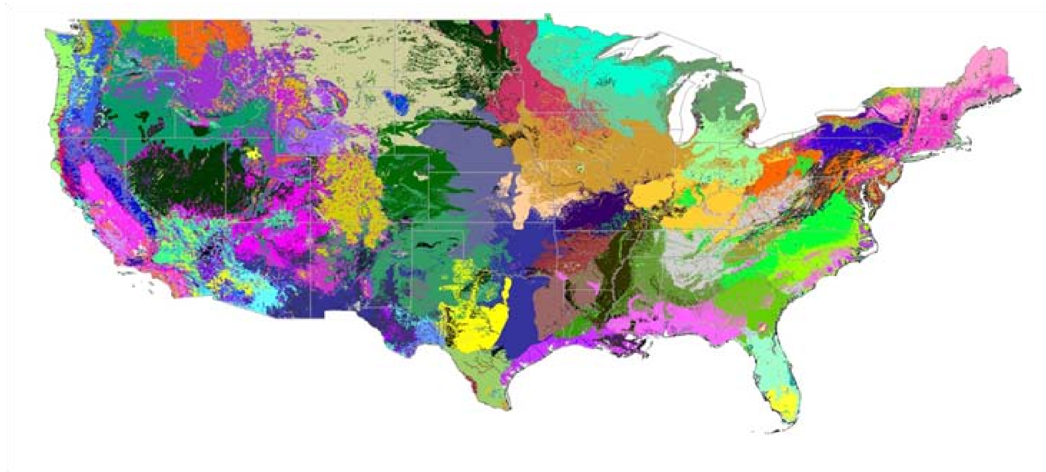


2050

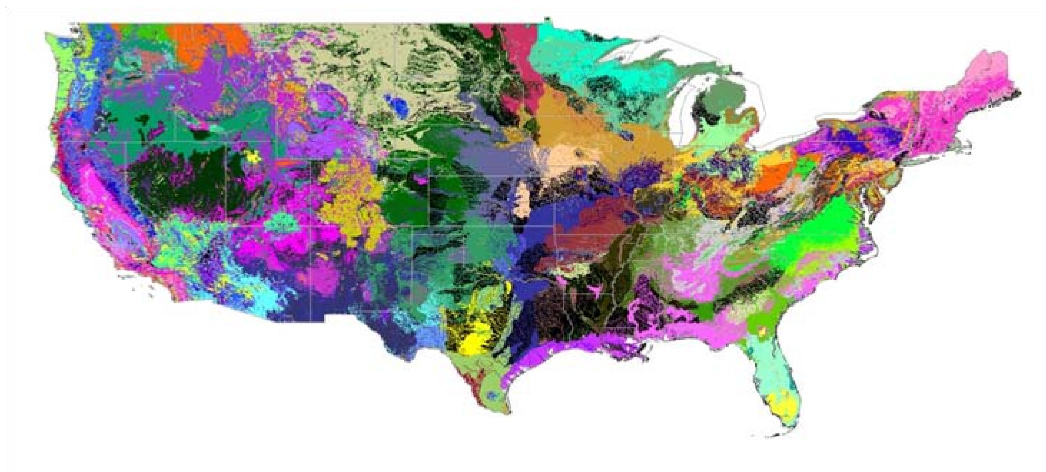


2080

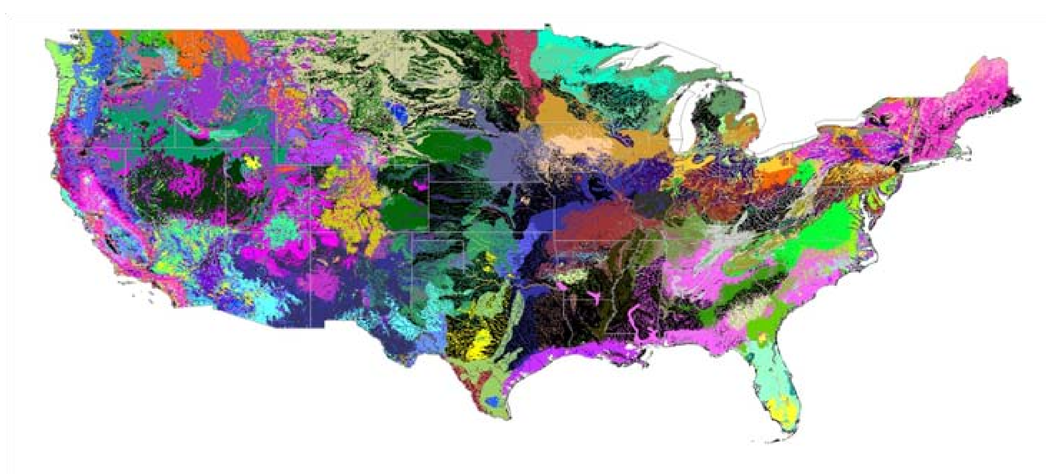
Figure 13. A1 Scenario, PCM Model; TNC categories.



Current

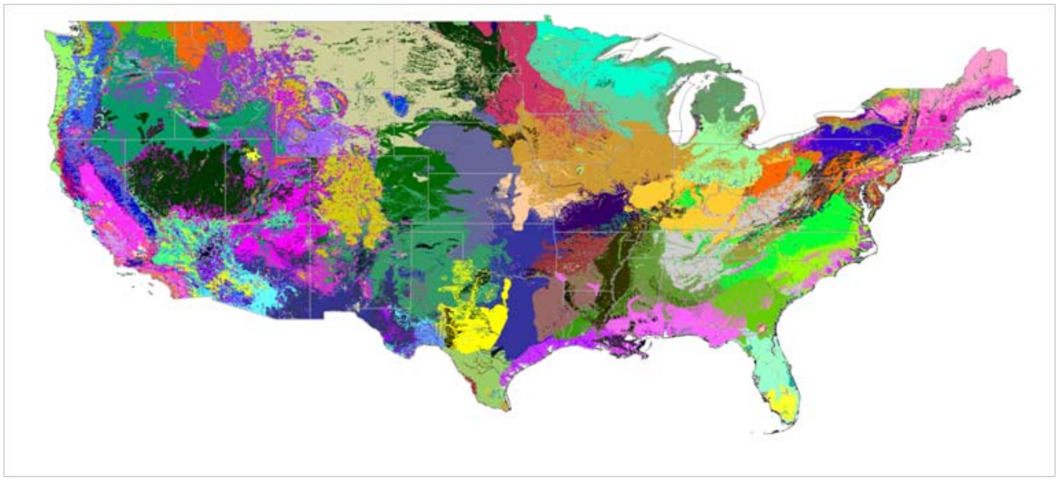


2050

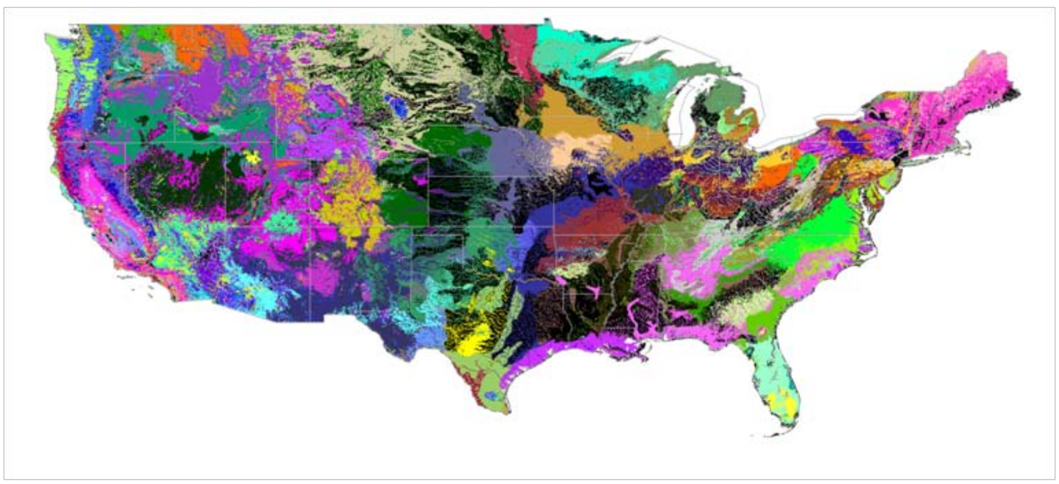


2080

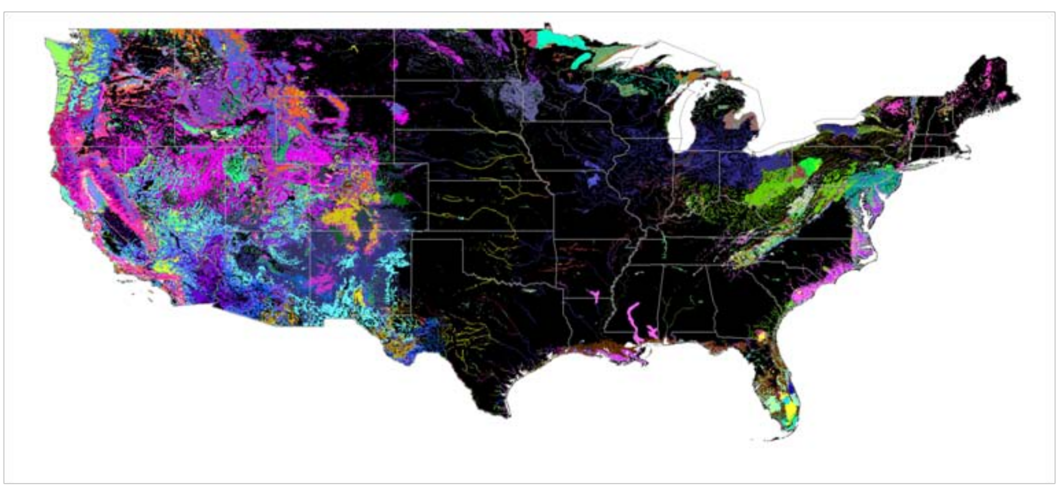
Figure 14. B1 Scenario, Hadley Model; TNC categories.



Current



2050



2080

Figure 15. A1 Scenario, Hadley Model; TNC categories.

3 Installation Analyses

3.1 Step A1: Forecasting installation biome shifts

In this step, one queries the future maps and asks how individual installations are likely to change, from an ecosystem perspective, over the 21st century. This was done by generating a page of images for each major installation that shows the area around each installation for each of the nine maps, and generating a rank-ordering of installations with respect to significance of change (discussed below). Appendix B (p 36) includes the results for select installations. (Figure 16 shows one example.) The location of an area around the installation is shown against the United States. The remaining maps “zoom into” this area. The map at the top-right shows the current ecosystem types. The middle row shows the images of the same area for the years 2050 and 2080. The columns represent the PCM model, B1 scenario; the PCM model, A1 scenario; the Hadley model, B1 scenario; and the Hadley A1, scenario. The top-left box provides an ecosystem/land-cover legend for the most commonly occurring categories across all of the maps on the page.

It is extremely important to read these maps with the following caveats. First, the Hadley and PCM models were chosen to represent relative extremes in GCM forecasts. Similarly, the A1 and B1 gas-emission scenarios provide relative extremes in greenhouse gas emission rates over the 21st century. Secondly, compared with the size of installations, the resolution of the national-scale study is relatively crude. Therefore, on-installation ecosystem details are not captured. Third, the classification of ecosystem type on the installations is likely to be crude – relative to the on-installation knowledge of local ecologists. Fourth, the forecast change identifies the very long-term steady state of an area. It does not take into account the rate of change to that system, which is mediated by seed dispersal rates, longevity of mature trees, human system management initiatives, susceptibility to disease, and inter-species competition.

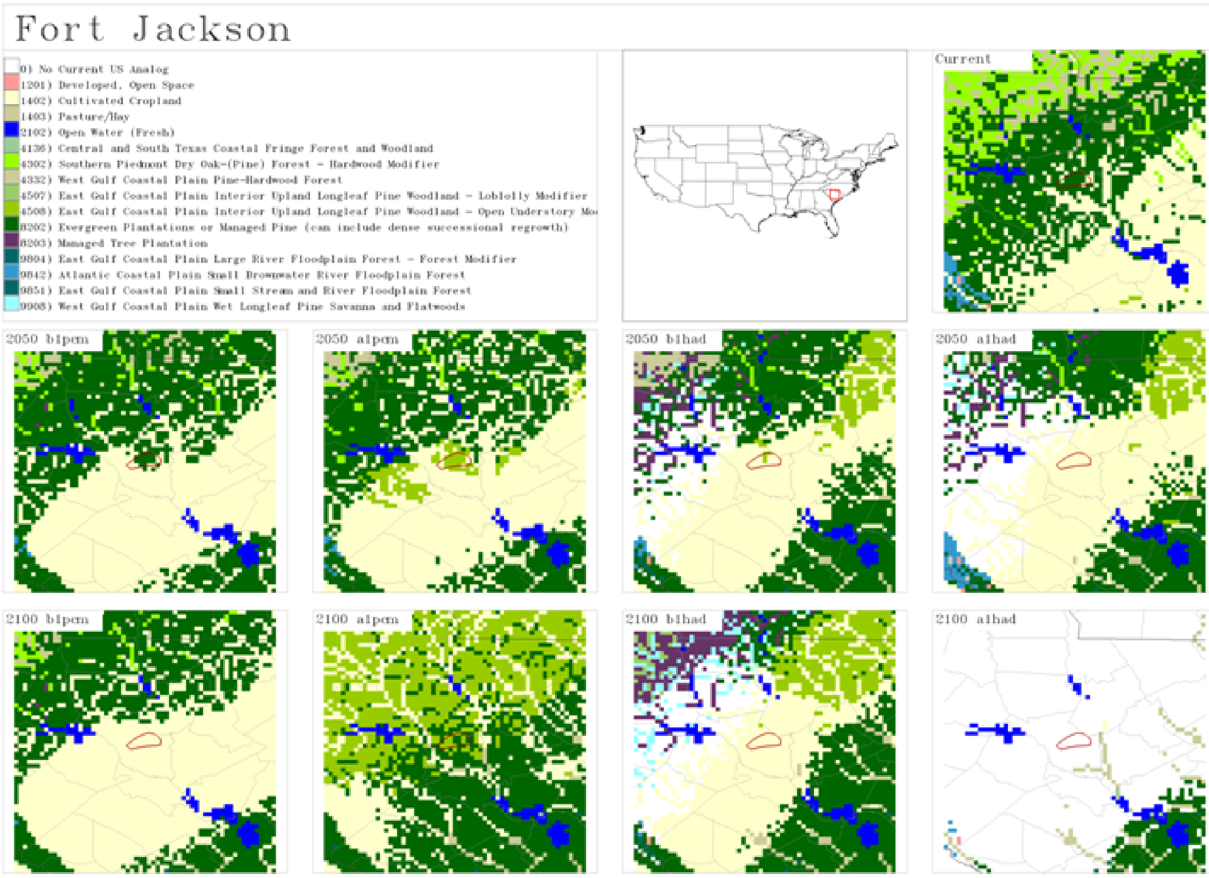


Figure 16. Sample installation report showing local biome shift potentials.

3.2 Step A2: Find future areas in the present

Another way to understand the potential for biome shift change and to visualize the relative amount of change is to display where one can go today to find the future ecosystem-driving conditions anticipated in the future. Consider Fort Jackson, SC (Figure 17). The images are arranged similarly to those in Figure 16: Current conditions are at top left, 2050 is the middle row, and 2080 is the bottom row. The first two columns are PCM model results, B1 scenario first and A1 scenario second. The last two columns are Hadley model results, again with B1 the first and A1 the second. The color table runs from dark green through bright green to white, with dark green being identical or very similar to the target.

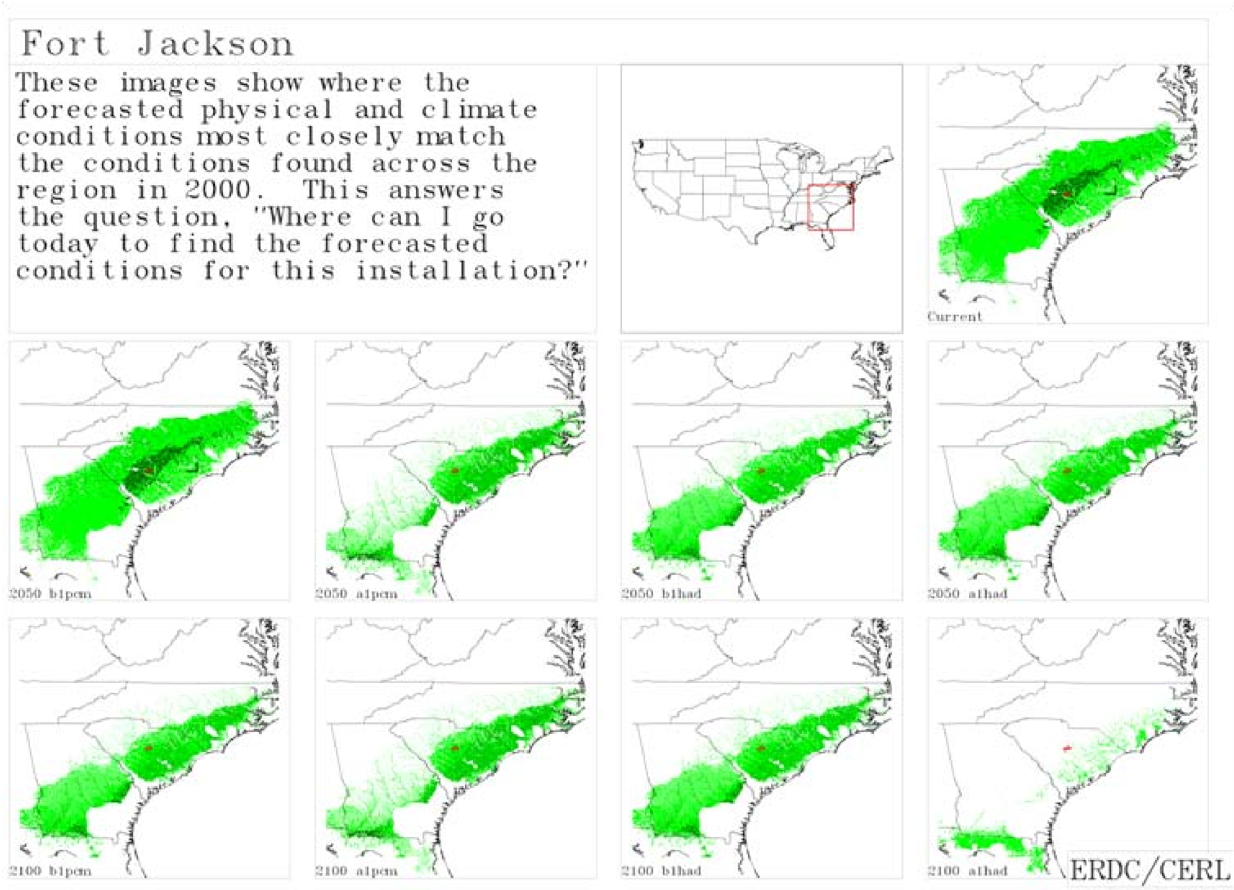


Figure 17. Current location of forecast ecosystem conditions.

The PCM B1 scenario suggests little change for this area by 2050. To find the best current example of conditions estimated for 2080 one needs to travel to the east area in Georgia. The Hadley A1 panel suggests that there are no areas that one can currently go today to find the conditions anticipated for Fort Jackson in 2080, but that the Florida panhandle offers the best analog. The gross graphical suggests that one need move further and further south to find areas that are similar to the modeled futures. Appendix B to this report (p 36) includes panels for selected installations.

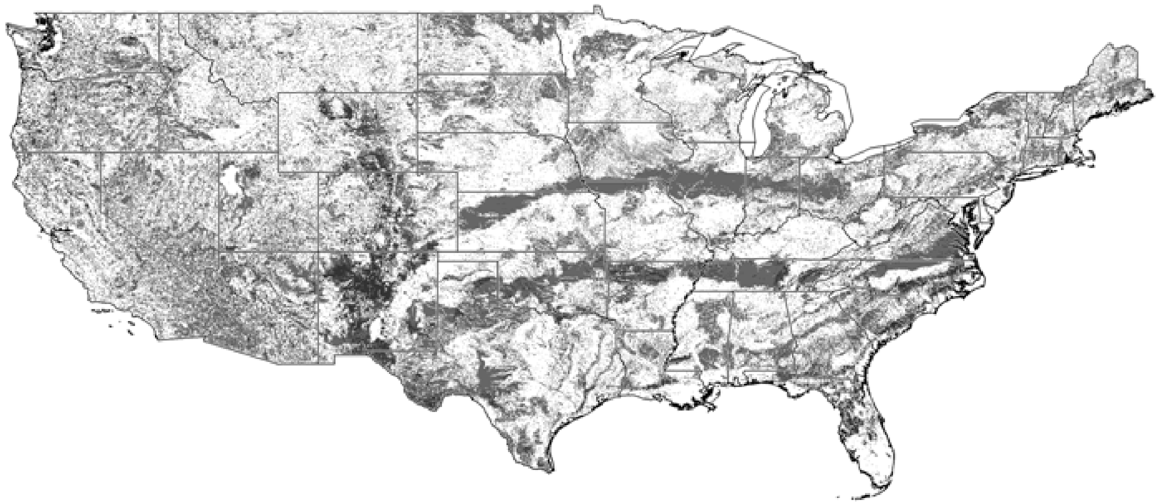
3.3 Step A3: Rank areas by degree of change

Which installations are most at-risk for change due to the consequences of potential ecosystem shift? To rank-order installations, the boundary of each installation was used to “cookie-cutter” into the current and future maps over the eight future GAP-based maps to tabulate the ecosystem type and amount of each type. For each future map, the percent of the installation that still held the current ecosystem types was calculated. The percentage across all eight future maps was then averaged and used to rank-order the installations. Appendix C (p 116) lists all of the Army installations beginning with the least changeable and ending with the installations likely to be most dramatically affected. The last column (on which the table is sorted) lists the average of the counts of changes for each model/scenario/time combination.

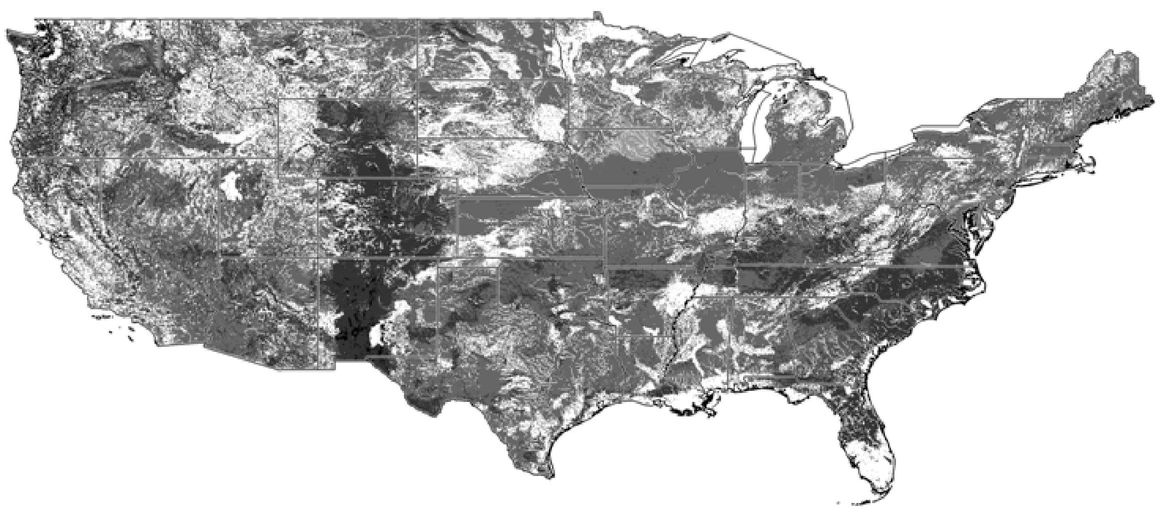
3.4 Step A4: Looking at raw change across CONUS

Another way to view the data is to simply look for degree of change over time across the 16 ecological drivers. Remember that each of the driver maps encodes the number of standard deviations from each map's average for each gridcell. Consider that these 16 values represent coordinates in a 16-dimensional space. One way to calculate overall change is to find the straight-line distance using the Pythagorean theorem between the 16-D coordinate for a space in 2000 and the 16-D coordinate representing a later time. This method assumes that one unit of change in one dimension is equivalent to one unit of change in every other dimension.

Figures 18 to 21 each show the two time steps (2050 and 2080) for each of the four model/scenario combinations. The images use a grey-scale color table with areas that change little in white and those that change a lot in black. Each image uses the same color table to allow for easy visual comparison. As expected, the Hadley model is consistently associated with greater change than the PCM model. Also, the higher emission scenario (A1) is associated with across the board greater change. In every map, the degree of change is quite variable across the nation, and the patterns of change are different across models and scenarios.



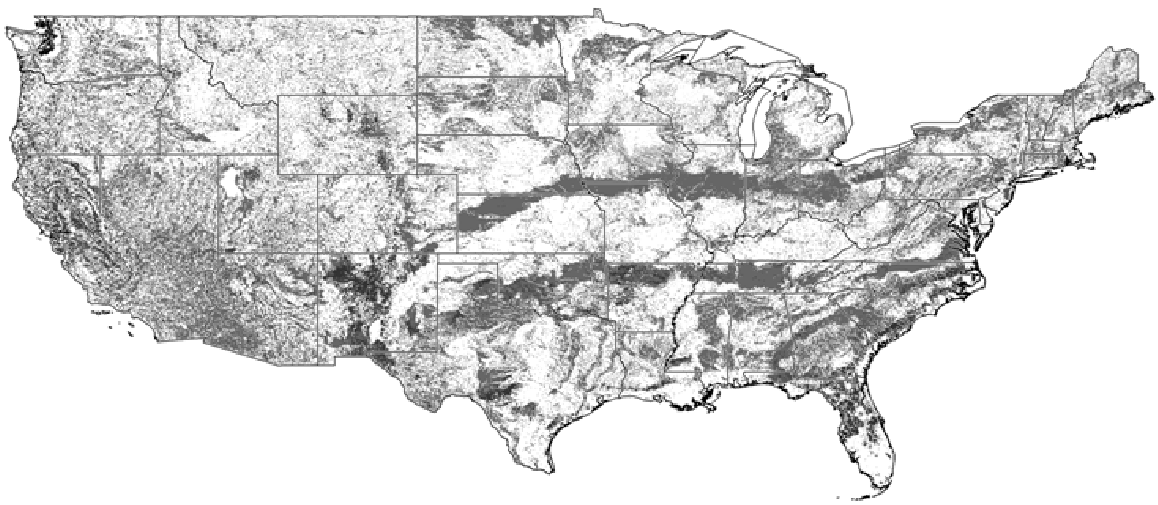
2005



2080

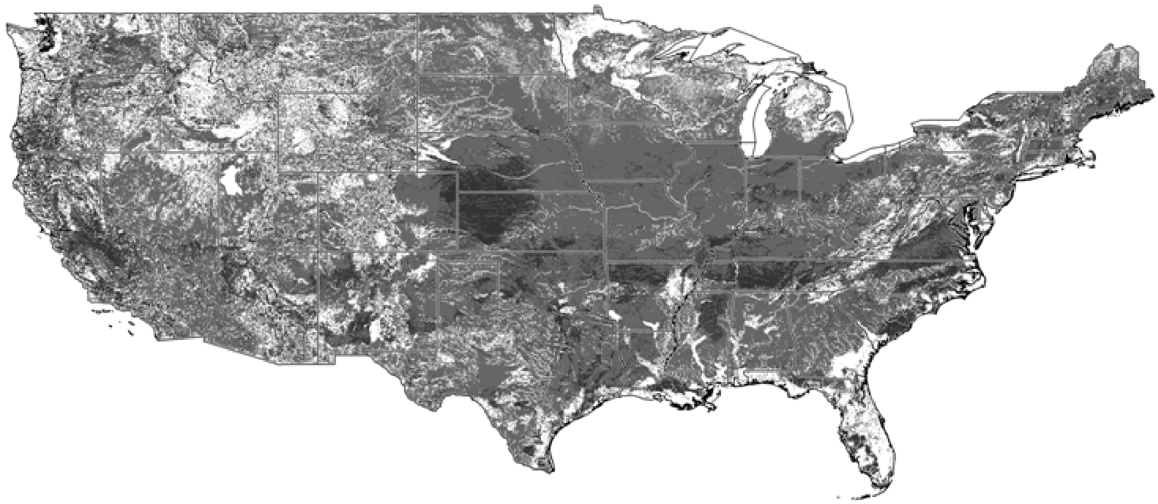
Figure 18. Degree of change. Model: PCM, Scenario: A1.

2005

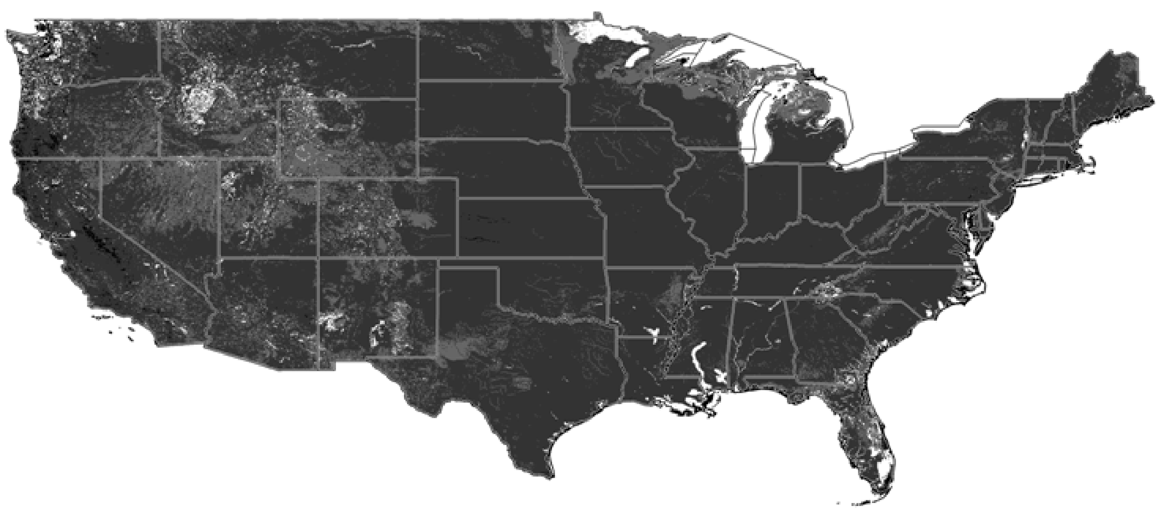


2080

Figure 19. Degree of change. Model: PCM, Scenario: B1.

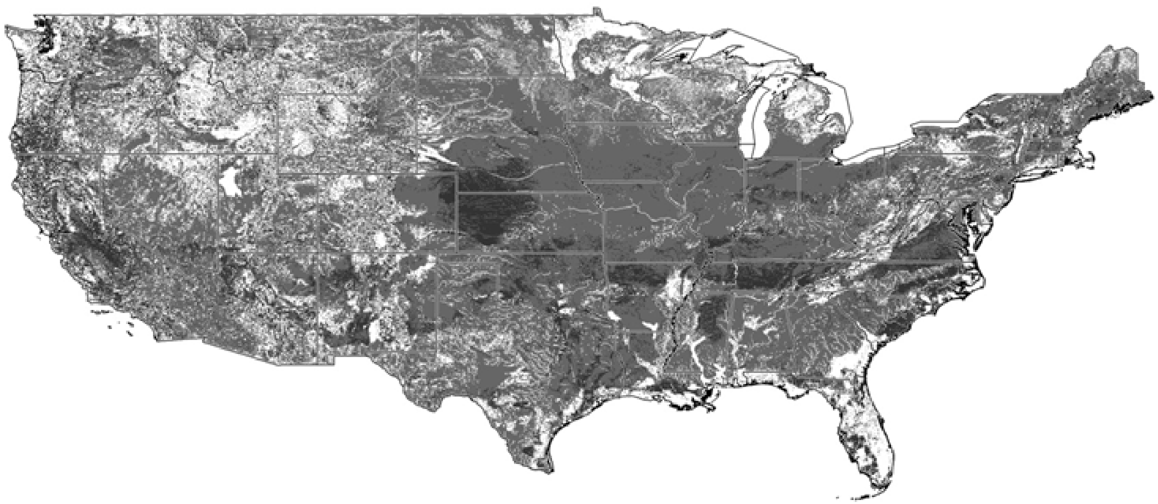


2005

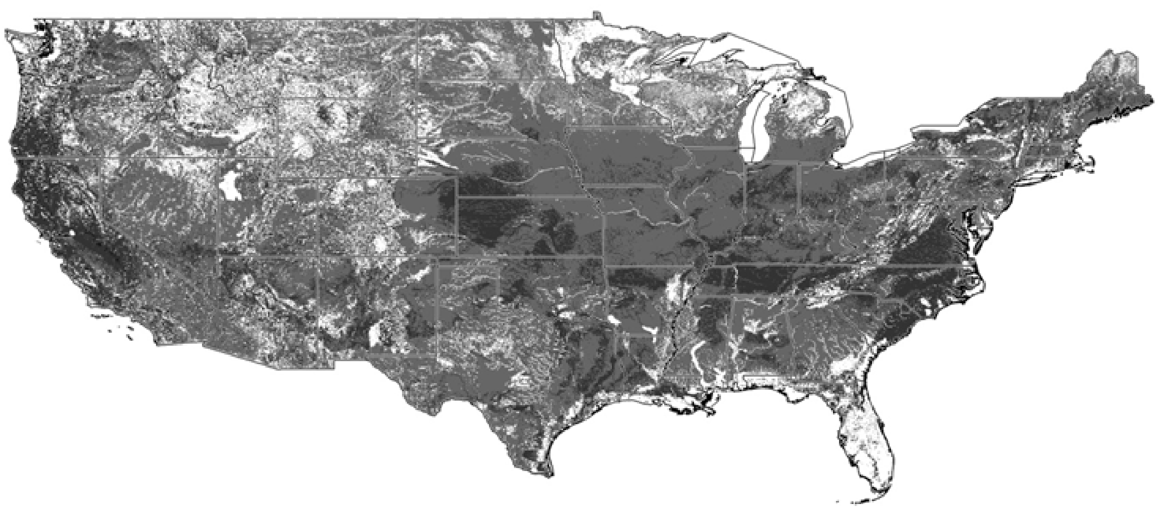


2080

Figure 20. Degree of change. Model: Hadley, Scenario: A1.



2005



2080

Figure 21. Degree of change. Model: Hadley, Scenario: B1.

4 Conclusions

This work has addressed three questions regarding the anticipated implications of forecast climate change in the CONUS for US Army installations.

4.1 "Which installations are most at-risk with respect to ecosystem changes?"

This work investigated the potential for ecosystem shifts on 134 military installations and tabulated the percent of anticipated shift in Appendix C (p 116). That potential was estimated for all eight combinations of two GCMs (Hadley, a model that tends to predict significant change; and PCM, a model that predicts less severe change), two scenarios (A1, higher carbon emissions, and B1, lower emissions), and two time periods. This work concludes that the major training/testing installations that appear to be most at risk include:

- Yakima
- Fort Huachuca
- Fort Drum
- Fort Hunter-Liggett
- Fort Jackson
- Fort Knox
- Fort Bliss
- Fort Sill
- Fort Campbell
- Fort Gordon
- Fort Benning.

4.2 What is the range of anticipated ecosystem shifts based on the forecasts of general circulation models (GCMs)?

The two GCMs chosen represent a reasonable range of climate condition change forecasts. The models generally agreed in the direction of system changes, varying only in degree. Based on this analysis, 66–88 percent of installations are expected to see ecosystem driver conditions (weather, soils, and insolation) change enough by 2050 to support a different system than now exists. By 2080 that range shifts to 68–99 percent. By this analysis, this work concludes that over the coming decades, most installations are expected to see clear evidence of climate change impact on the types of plants and animals that naturally thrive on their lands.

4.3 Where can one go today to find the ecosystem drivers (weather, climate, soil, and sun) anticipated in the future?

Appendix B to this report (p 36) includes three panels of analysis results for some of the largest Army training and testing installations. The third panel in each set maps where one might go today to find the ecosystem driver conditions that most closely match the anticipated future conditions for the installation. In general one must travel south, or down-slope, to find the anticipated future conditions today. However, in the long term, it becomes increasingly likely that there is no nearby location that is like the anticipated future.

As noted earlier, this analysis looks only at the anticipated changing conditions that support ecosystems and that matches future conditions to current conditions to see what ecosystems are currently supported by specific combinations of conditions. While this analysis might predict what ecosystems might emerge in the future if conditions were to stabilize, it absolutely does not forecast when the new system will replace the current system. However, this analysis does suggest that across CONUS there will be a long-term mismatch between extant systems and the conditions upon which those systems depend. Ecological models may become useful for forecasting change rate and process, but the consequences of these changes will be the subject of study for many decades to come.

Acronyms and Abbreviations

Term	Definition
BRD	Biological Resources Discipline
CEERD	U.S. Army Corps of Engineers, Engineer Research and Development Center
CERL	Construction Engineering Research Laboratory
CONUS	Continental United States
DC	District of Columbia
ERDC	Engineer Research and Development Center
GAP	Gap Analysis Program
GCM	general circulation model
GIS	geographic information system
MGC	Multivariate Geographic Clustering
NCAR	National Center for Atmospheric Research
PCM	Parallel Climate Model
POP	Parallel Ocean Program
TNC	The Nature Conservancy
TR	Technical Report
URL	Universal Resource Locator
US	United States
USGS	U.S. Geological Survey
WWW	World Wide Web

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Appendix A: Legends

1201) Developed, Open Space
1202) Developed, Low Intensity
1203) Developed, Medium Intensity
1204) Developed, High Intensity
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
2103) Open Water (Brackish/Salt)
3105) Undifferentiated Barren Land
3111) North American Warm Desert Active and Stabilized Dune
3116) Great Lakes Dune
3121) Inter-Mountain Basins Active and Stabilized Dune
3201) North American Warm Desert Bedrock Cliff and Outcrop
3202) Rocky Mountain Cliff, Canyon and Massive Bedrock
3203) Western Great Plains Cliff and Outcrop
3204) Great Lakes Acidic Rocky Shore and Cliff
3209) North Pacific Montane Massive Bedrock, Cliff and Talus
3216) Inter-Mountain Basins Cliff and Canyon
3218) Colorado Plateau Mixed Bedrock Canyon and Tableland
3301) Western Great Plains Badland
3405) North American Warm Desert Playa
3407) Inter-Mountain Basins Playa
3501) North Pacific Alpine and Subalpine Bedrock and Scree
3502) North American Alpine Ice Field
3503) Rocky Mountain Alpine Bedrock and Scree
3504) Mediterranean California Alpine Bedrock and Scree
3605) North American Warm Desert Pavement
3607) North American Warm Desert Volcanic Rockland
4101) Central and Southern Appalachian Northern Hardwood Forest
4104) Northeastern Interior Dry Oak Forest-Hardwood Modifier
4109) Southern and Central Appalachian Oak Forest - Xeric
4110) North Pacific Oak Woodland
4111) Rocky Mountain Aspen Forest and Woodland
4113) Laurentian-Acadian Northern Hardwoods Forest
4114) Northeastern Interior Dry-Mesic Oak Forest
4115) Ozark-Ouachita Dry-Mesic Oak Forest
4116) Southern Interior Low Plateau Dry-Mesic Oak Forest
4118) Crosstimbers Oak Forest and Woodland
4120) North-Central Interior Dry-Mesic Oak Forest and Woodland
4124) North-Central Interior Maple-Basswood Forest
4125) Southern and Central Appalachian Oak Forest
4126) Allegheny-Cumberland Dry Oak Forest and Woodland - Hardwood
4133) Atlantic Coastal Plain Dry and Dry-Mesic Oak Forest
4136) Central and South Texas Coastal Fringe Forest and Woodland
4140) East-Central Texas Plains Post Oak Savanna and Woodland
4141) East-Central Texas Plains Riparian Forest
4143) Madrean Encinal
4144) Mediterranean California Mixed Oak Woodland
4147) Inter-Mountain Basins Curl-leaf Mountain Mahogany Woodland and Shrubland
4152) Edwards Plateau Limestone Savanna and Woodland
4201) Boreal Aspen-Birch Forest
4204) West Gulf Coastal Plain Mesic Hardwood Forest
4207) Ozark-Ouachita Mesic Hardwood Forest
4212) Atlantic Coastal Plain Southern Maritime Forest
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier
4309) East Gulf Coastal Plain Interior Shortleaf Pine-Oak Forest - Mixed Modifier
4313) Northern Atlantic Coastal Plain Dry Hardwood Forest
4315) Madrean Pine-Oak Forest and Woodland
4316) Madrean Upper Montane Conifer-Oak Forest and Woodland
4317) Mediterranean California Lower Montane Black Oak-Conifer Forest and Woodland
4318) Mediterranean California Red Fir Forest
4319) North Pacific Dry Douglas-fir-(Madrone) Forest and Woodland
4320) Mediterranean California Mixed Evergreen Forest
4323) Laurentian-Acadian Northern Pine-(Oak) Forest
4324) Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland
4326) Boreal White Spruce-Fir-Hardwood Forest
4327) Laurentian-Acadian Pine-Hemlock-Hardwood Forest
4328) Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland
4330) Central Appalachian Oak and Pine Forest
4331) Appalachian Hemlock-Hardwood Forest
4332) West Gulf Coastal Plain Pine-Hardwood Forest
4333) Acadian Low-Elevation Spruce-Fir-Hardwood Forest
4334) Southern Ridge and Valley Dry Calcareous Forest
4335) Central Appalachian Pine-Oak Rocky Woodland
4338) North Pacific Lowland Mixed Hardwood-Conifer Forest and Woodland
4401) Southern and Central Appalachian Cove Forest
4402) South-Central Interior Mesophytic Forest
4404) Mediterranean California Mesic Serpentine Woodland and Chaparral
4501) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Offsite Hardwood Modifier
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Loblolly Modifier
4508) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Open Understory Modifier
4511) Central and Southern California Mixed Evergreen Woodland
4512) Colorado Plateau Pinyon-Juniper Woodland
4514) Great Basin Pinyon-Juniper Woodland
4518) Madrean Pinyon-Juniper Woodland
4519) Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
4520) California Montane Jeffrey Pine-(Ponderosa Pine) Woodland
4521) Mediterranean California Subalpine Woodland
4522) North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest
4523) North Pacific Mountain Hemlock Forest
4524) Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
4525) Northern Rocky Mountain Subalpine Woodland and Parkland
4526) Rocky Mountain Foothill Limber Pine-Juniper Woodland
4527) Rocky Mountain Lodgepole Pine Forest
4528) Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland
4529) Northern Rocky Mountain Ponderosa Pine Woodland and Savanna
4530) Southern Rocky Mountain Ponderosa Pine Woodland
4531) Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4532) Rocky Mountain Subalpine-Montane Limber-Bristlecone Pine Woodland
4533) Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland

Figure A1. Legend for GAP maps.

182) 47% –North Atlantic Coast
183) 61% –North Central Tillplain
184) 53% –Northern Appalachian / Acadian
185) 76% –Ouachita Mountains
186) 94% –Ozarks
187) 31% –Piedmont
188) 53% –Prairie–Forest Border
189) 94% –Southern Blue Ridge
269) 54% –Southern Shortgrass Prairie
355) 74% –Tropical Florida
423) 92% –Valdivian Temperate Forests
431) 70% –Uruguayan Savanna
432) 56% –Espinal
434) 37% –Low Monte
452) 45% –Chilean Matorral
496) 38% –California North Coast
497) 37% –Canadian Rocky Mountains
498) 57% –East Cascades – Modoc Plateau
499) 90% –East Gulf Coastal Plain
500) 33% –Florida Peninsula
502) 33% –Klamath Mountains
503) 81% –Mid–Atlantic Coastal Plain
573) 27% –Zagros Mountains Forest Steppe
610) 25% –Eastern Anatolian Montane Steppe
667) 78% –Mediterranean Dry Woodlands And Steppe
668) 36% –Mediterranean Woodlands And Forests
673) 85% –Baluchistan Xeric Woodlands
679) 52% –Central Persian Desert Basins
693) 64% –Registan–North Pakistan Sandy Desert
705) 56% –Central Appalachian Forest
706) 56% –Chesapeake Bay Lowlands
707) 30% –Cumberlands And Southern Ridge And Valley
708) 78% –Great Lakes
709) 58% –High Allegheny Plateau
710) 38% –Interior Low Plateau
711) 73% –Lower New England / Northern Piedmont
712) 61% –Mississippi River Alluvial Plain
714) 99% –Superior Mixed Forest
715) 31% –Upper East Gulf Coastal Plain
716) 44% –Western Allegheny Plateau
718) 41% –Arizona–New Mexico Mountains
720) 35% –Middle Rockies – Blue Mountains
721) 79% –Montane Cordillera
723) 25% –Okanagan
724) 29% –Pacific Northwest Coast
726) 27% –Sierra Nevada
727) 82% –South Atlantic Coastal Plain
728) 40% –Southern Rocky Mountains
729) 84% –Upper West Gulf Coastal Plain
731) 40% –Utah–Wyoming Rocky Mountains
732) 51% –West Cascades
733) 97% –West Gulf Coastal Plain
738) 77% –Boreal Shield
746) 100% –Gulf Coast Prairies And Marshes
747) 67% –Aspen Parkland
748) 86% –Central Mixed–Grass Prairie
749) 71% –Central Shortgrass Prairie
750) 48% –Central Tallgrass Prairie
751) 72% –Crosstimbers And Southern Tallgrass Prairie
752) 51% –Dakota Mixed–Grass Prairie
753) 53% –Edwards Plateau
754) 69% –Fescue–Mixed Grass Prairie
755) 90% –Northern Great Plains Steppe
756) 74% –Northern Tallgrass Prairie
757) 90% –Osage Plains/Flint Hills Prairie
760) 98% –California Central Coast
762) 37% –Great Central Valley
763) 71% –Apache Highlands
765) 30% –Chihuahuan Desert
766) 59% –Colorado Plateau
767) 70% –Columbia Plateau
768) 73% –Great Basin
770) 45% –Sonoran Desert
771) 53% –Tamaulipan Thorn Scrub
772) 60% –Wyoming Basins
806) 50% –Central Ranges Xeric Scrub

Figure A2. Legend for TNC maps.

Appendix B: Installation Biome Shift Forecasts

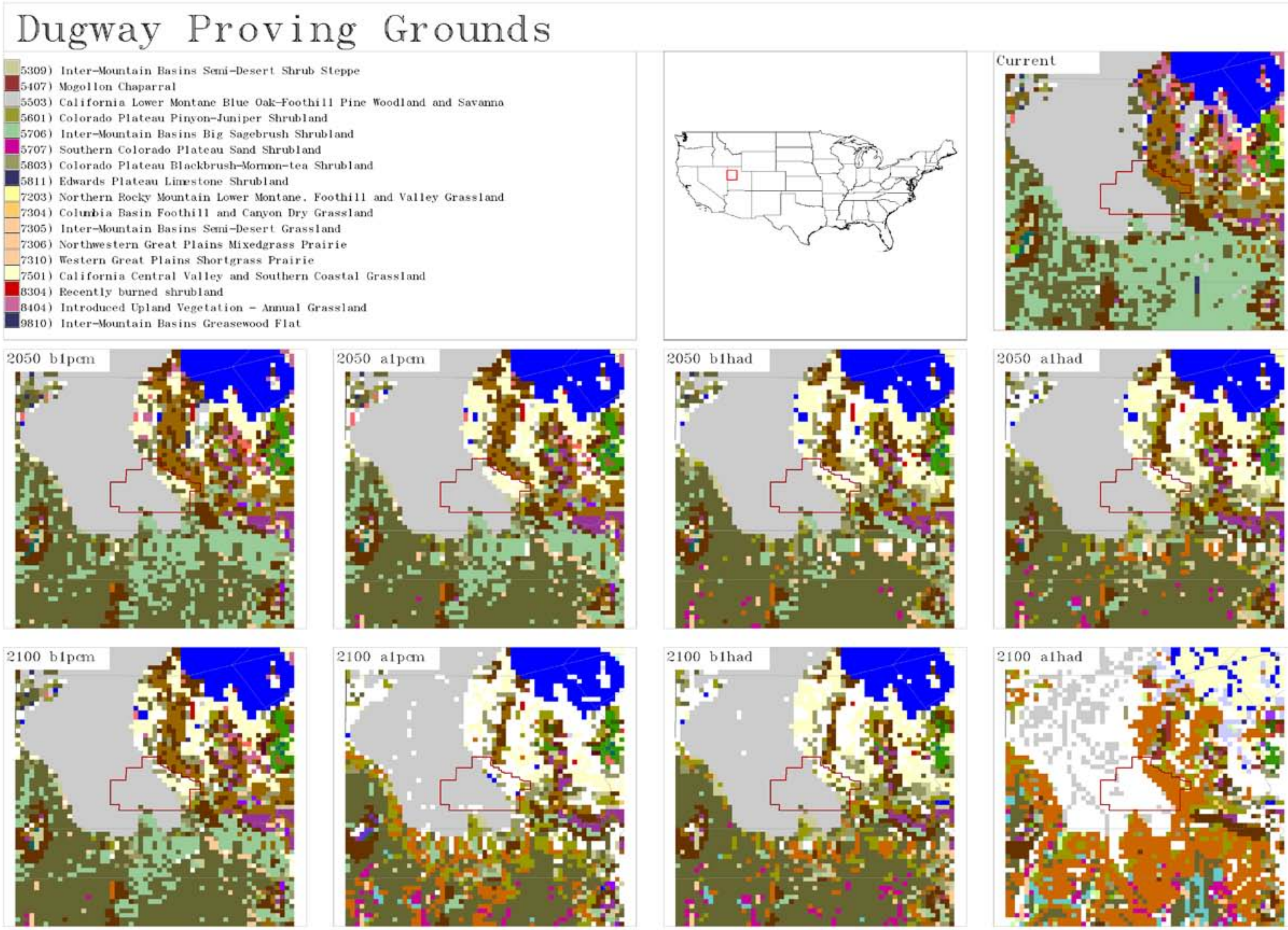
Installations are alphabetically ordered on the following pages:

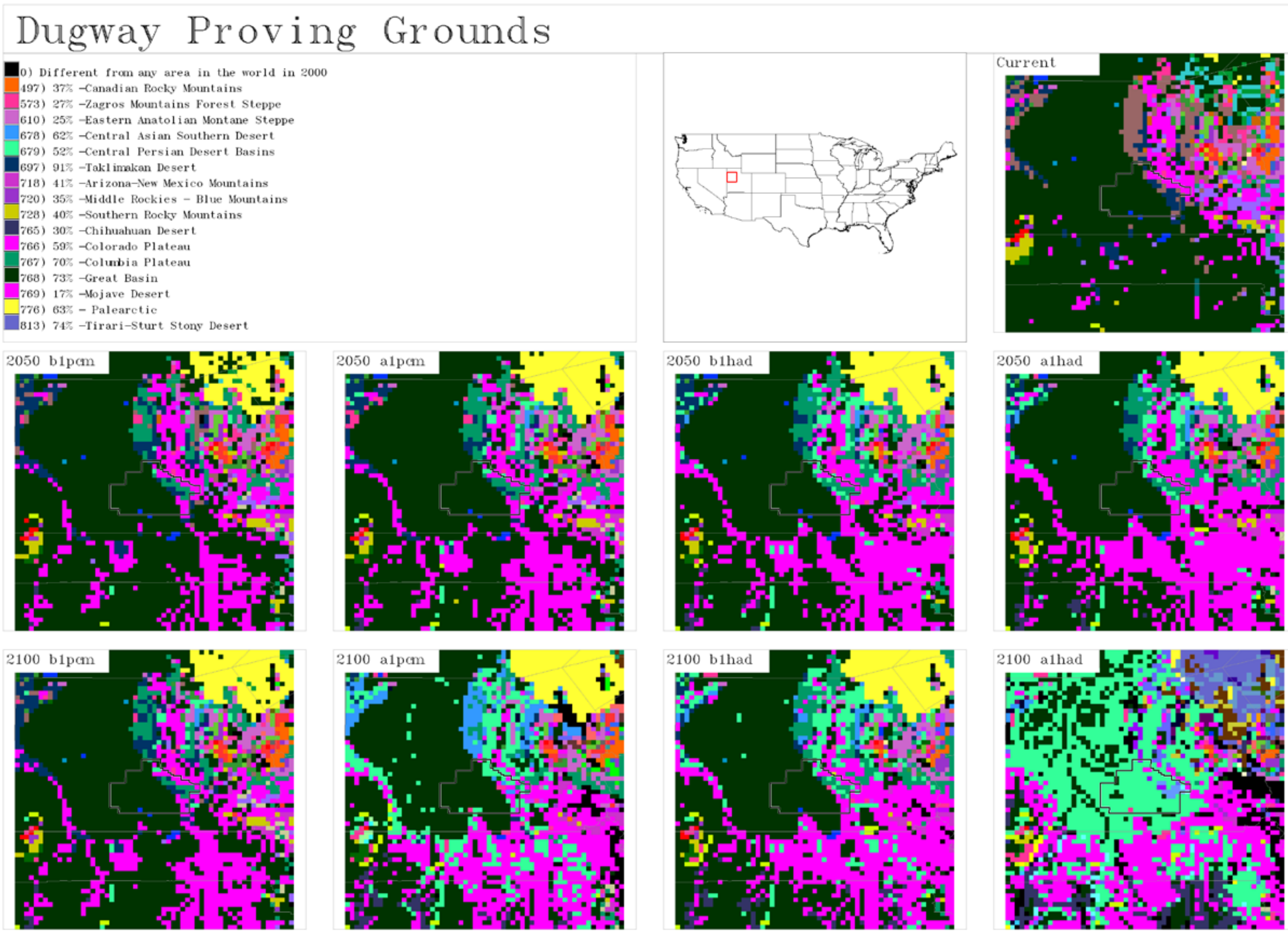
Each installation is illustrated with three panels:

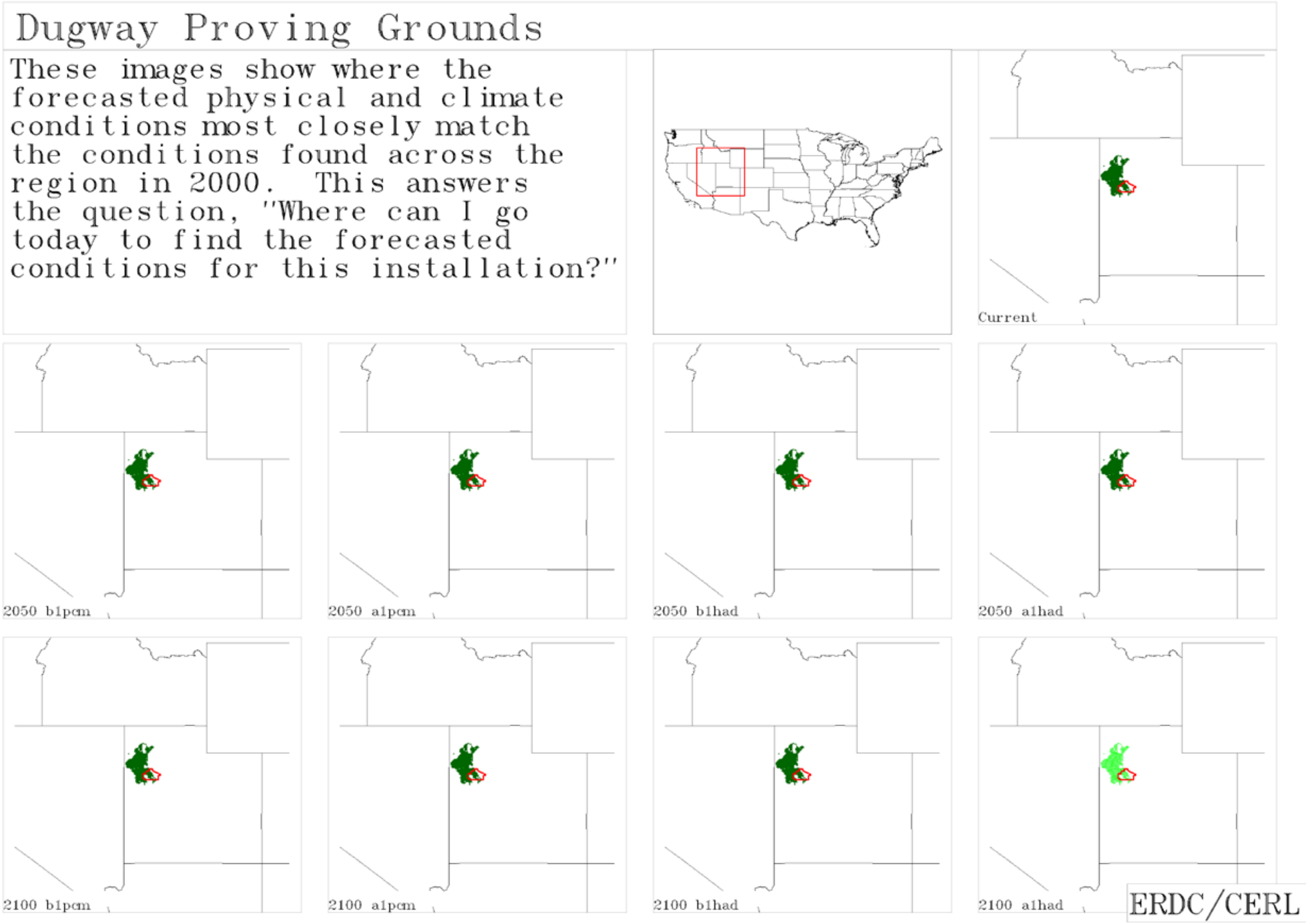
1. A series of current and future GAP-analysis maps.
2. A series of current and future TNC-analysis maps.
3. A series of maps showing where, today, one might go to find the future forecast conditions.

For each page, the location of an area around the installation is shown against the United States. The remaining maps "zoom into" this area. The map at the top-right shows the current ecosystem types. The middle row shows the images of the same area for 2050 and 2080. The columns represent the PCM model, B1 scenario; the PCM model, A1 scenario; the Hadley model, B1 scenario; and the Hadley A1, scenario. The top-left box for the GAP and TNC images provides an ecosystem/land-cover legend for the most commonly occurring categories across all of the maps on the page.

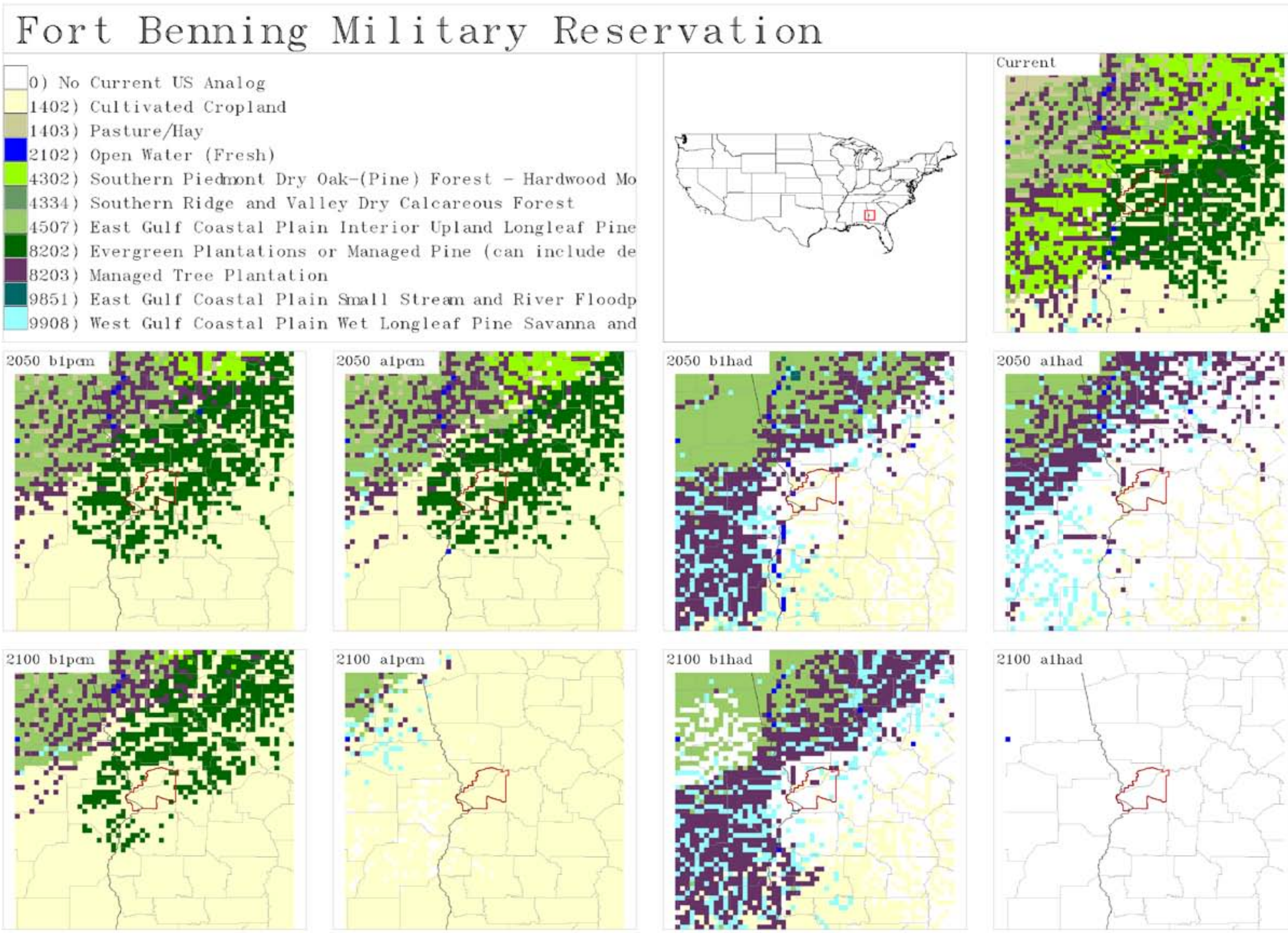
Dugway Proving Grounds

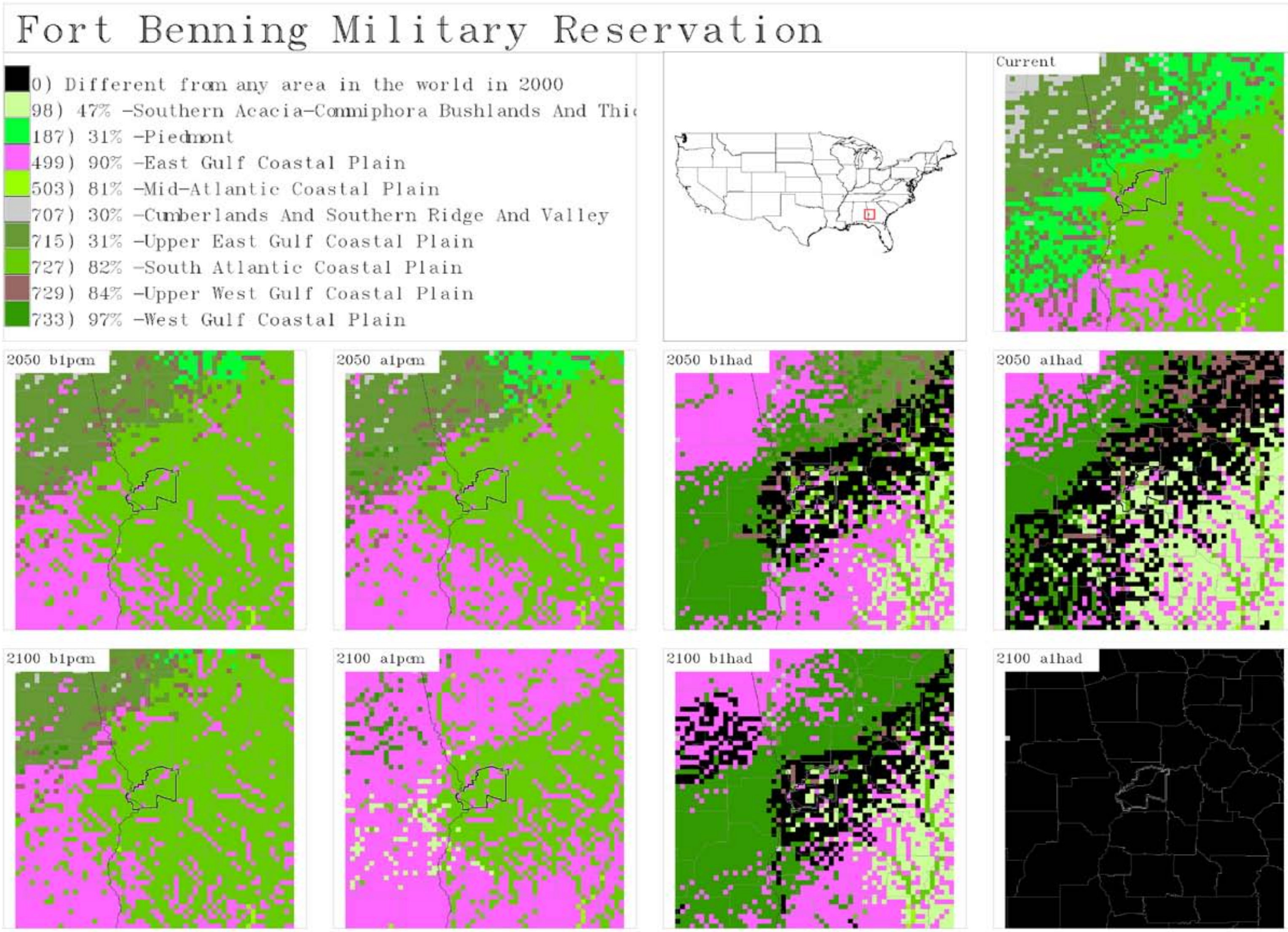


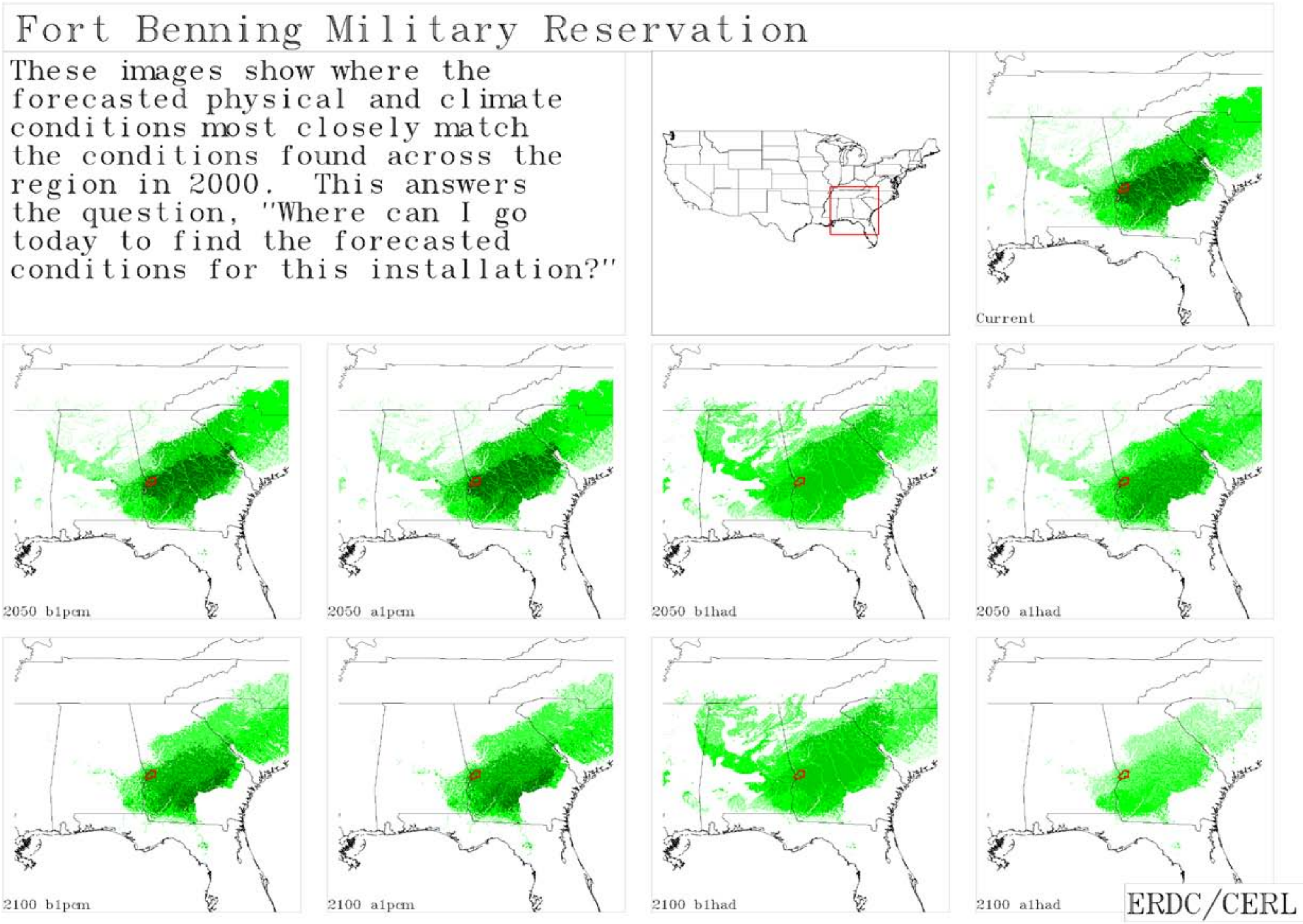

Dugway Proving Grounds
0) Different from any area in the world in 2000
497) 37% -Canadian Rocky Mountains
573) 27% -Zagros Mountains Forest Steppe
610) 25% -Eastern Anatolian Montane Steppe
678) 62% -Central Asian Southern Desert
679) 52% -Central Persian Desert Basins
697) 91% -Taklimakan Desert
718) 41% -Arizona-New Mexico Mountains
720) 35% -Middle Rockies - Blue Mountains
728) 40% -Southern Rocky Mountains
765) 30% -Chihuahuan Desert
766) 59% -Colorado Plateau
767) 70% -Columbia Plateau
768) 73% -Great Basin
769) 17% -Mojave Desert
776) 63% - Palearctic
813) 74% -Tirari-Sturt Stony Desert
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



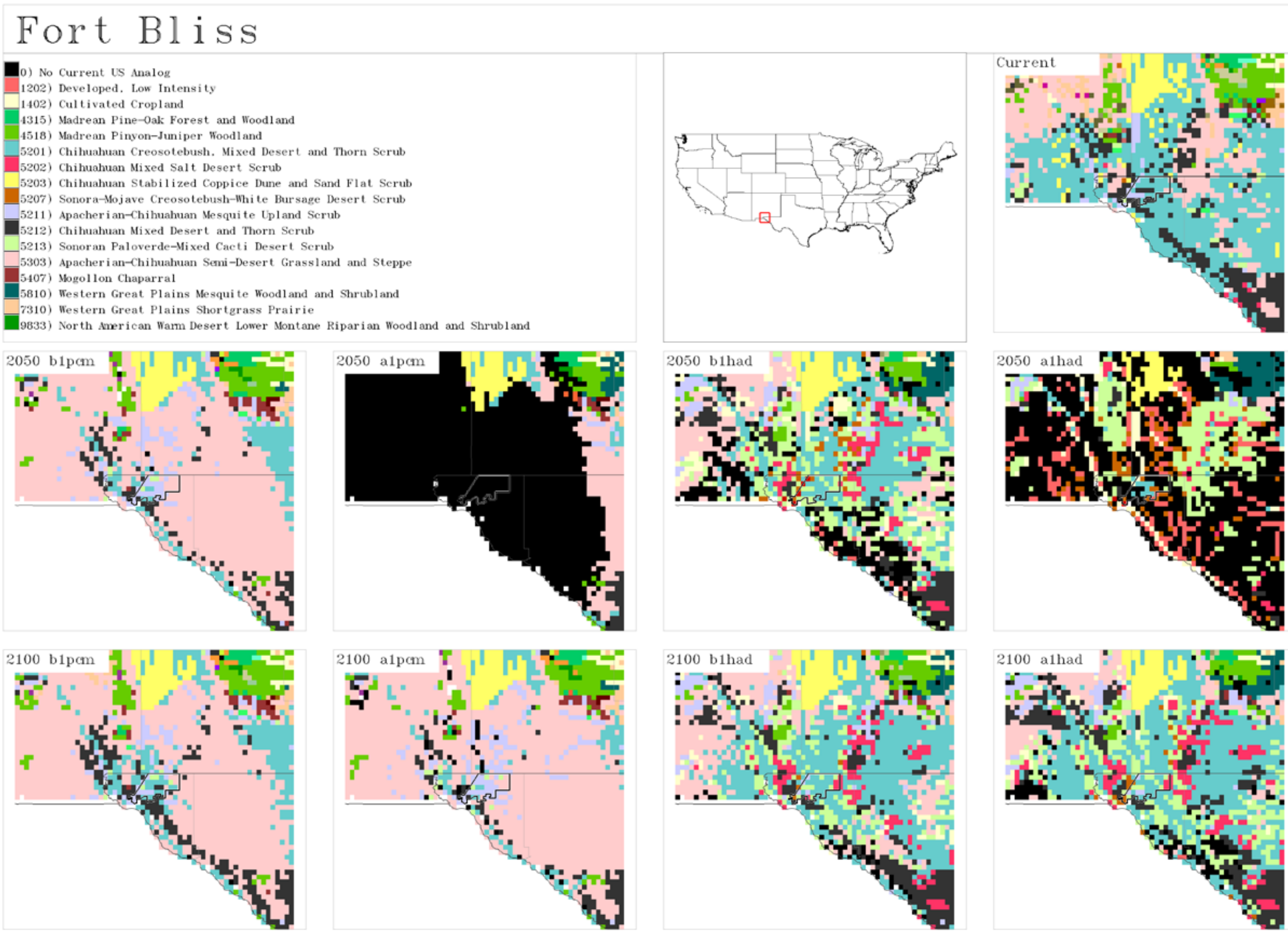
Fort Benning

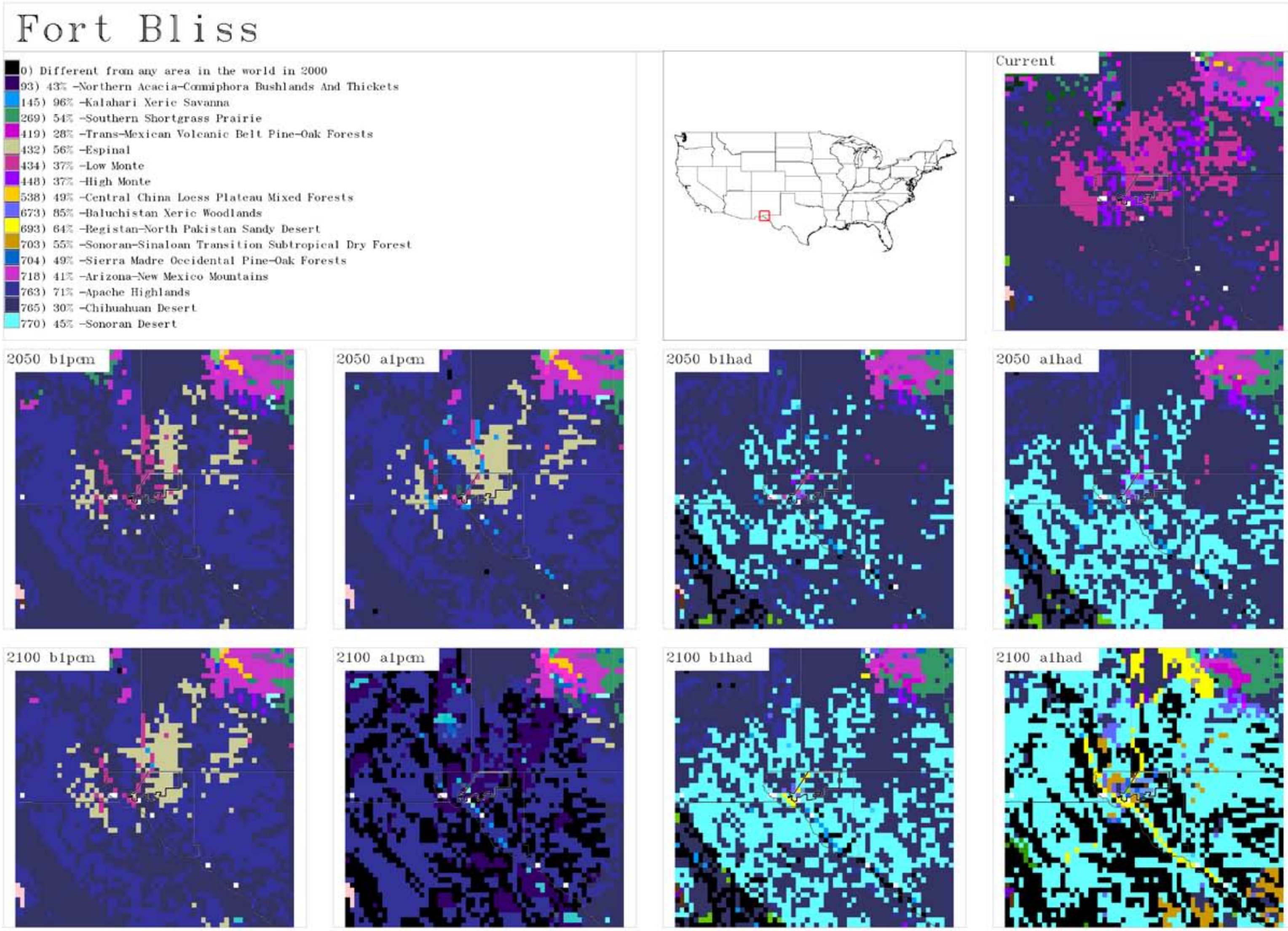

Fort Benning Military Reservation
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Mo
4334) Southern Ridge and Valley Dry Calcareous Forest
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine
8202) Evergreen Plantations or Managed Pine (can include de
8203) Managed Tree Plantation
9851) East Gulf Coastal Plain Small Stream and River Floodp
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

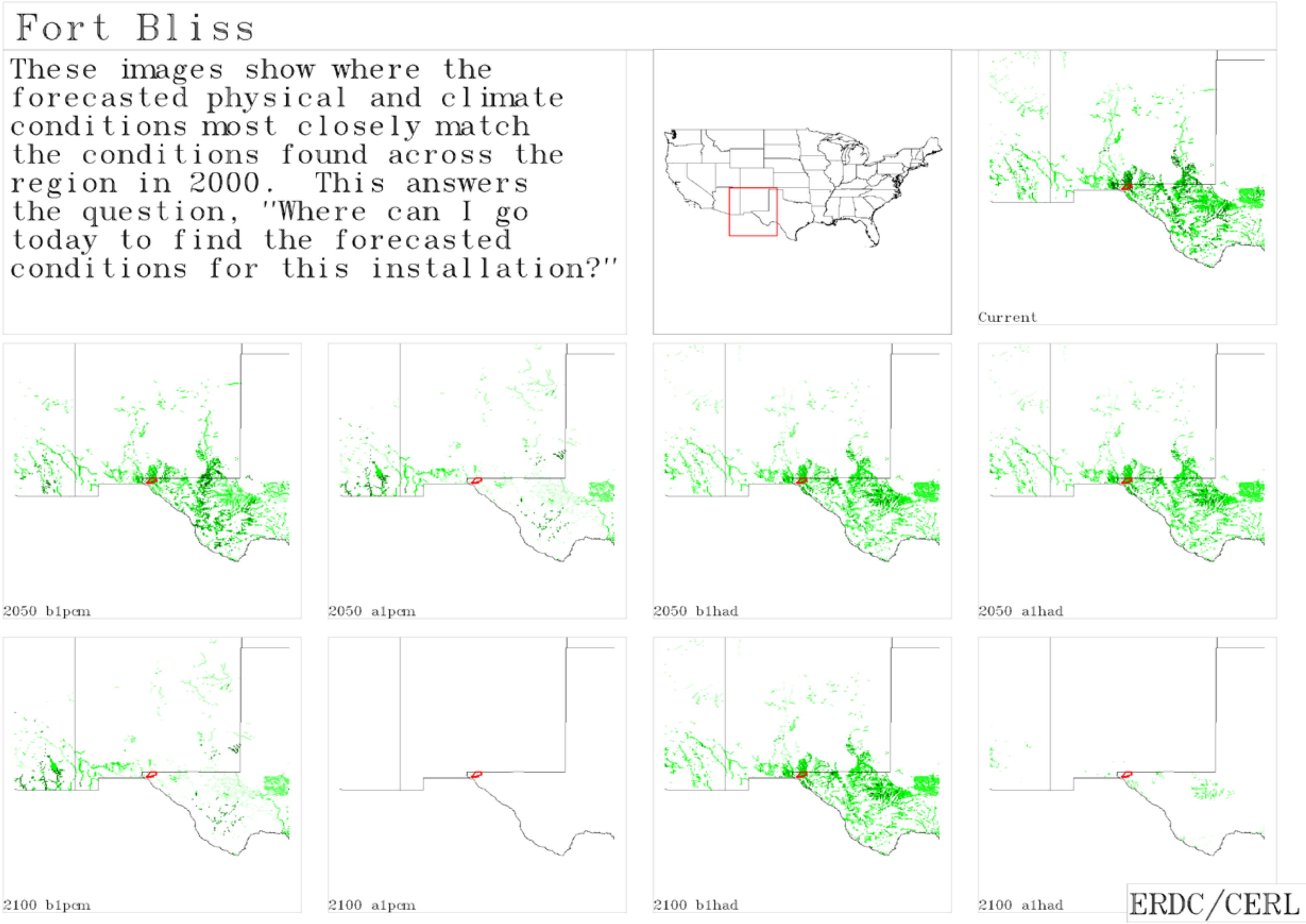

Fort Benning Military Reservation
0) Different from any area in the world in 2000
98) 47% -Southern Acacia-Commiphora Bushlands And Thi
187) 31% -Piedmont
499) 90% -East Gulf Coastal Plain
503) 81% -Mid-Atlantic Coastal Plain
707) 30% -Cumberlands And Southern Ridge And Valley
715) 31% -Upper East Gulf Coastal Plain
727) 82% -South Atlantic Coastal Plain
729) 84% -Upper West Gulf Coastal Plain
733) 97% -West Gulf Coastal Plain
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Fort Benning Military Reservation
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

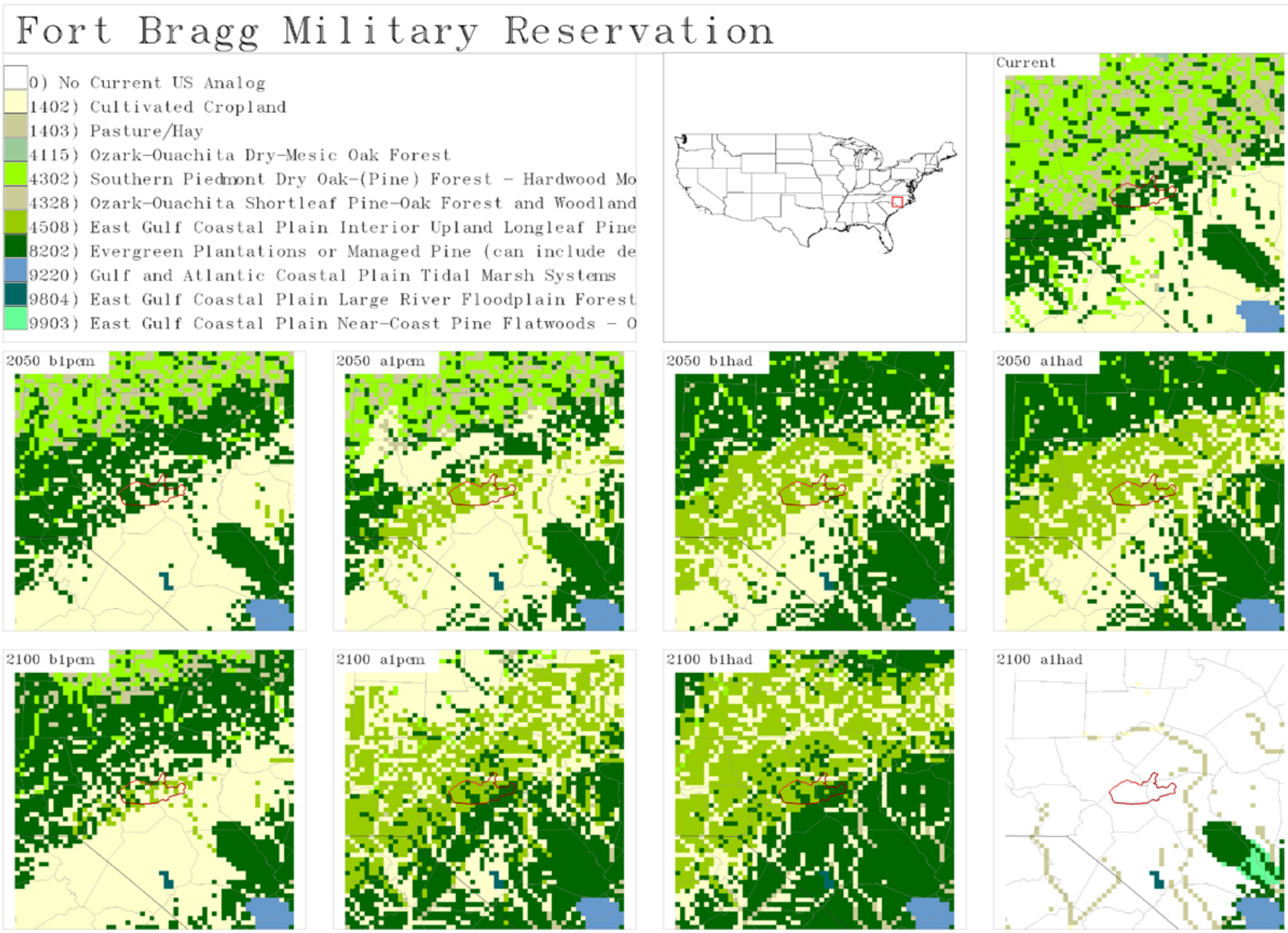
Fort Bliss

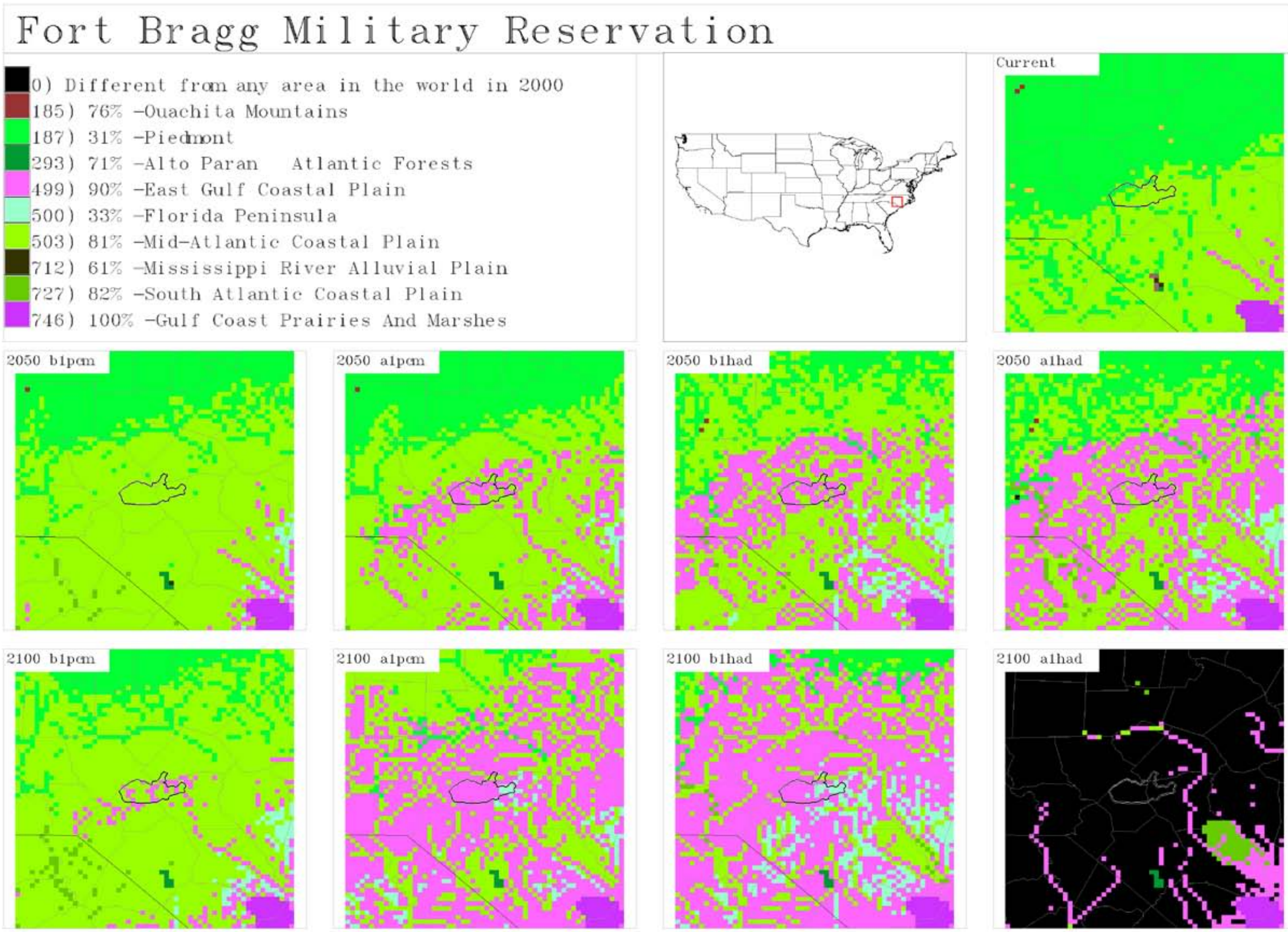

Fort Bliss
0) No Current US Analog
1202) Developed, Low Intensity
1402) Cultivated Cropland
4315) Madrean Pine-Oak Forest and Woodland
4518) Madrean Pinyon-Juniper Woodland
5201) Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub
5202) Chihuahuan Mixed Salt Desert Scrub
5203) Chihuahuan Stabilized Coppice Dune and Sand Flat Scrub
5207) Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5211) Apacherian-Chihuahuan Mesquite Upland Scrub
5212) Chihuahuan Mixed Desert and Thorn Scrub
5213) Sonoran Paloverde-Mixed Cacti Desert Scrub
5303) Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5407) Mogollon Chaparral
5810) Western Great Plains Mesquite Woodland and Shrubland
7310) Western Great Plains Shortgrass Prairie
9833) North American Warm Desert Lower Montane Riparian Woodland and Shrubland
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

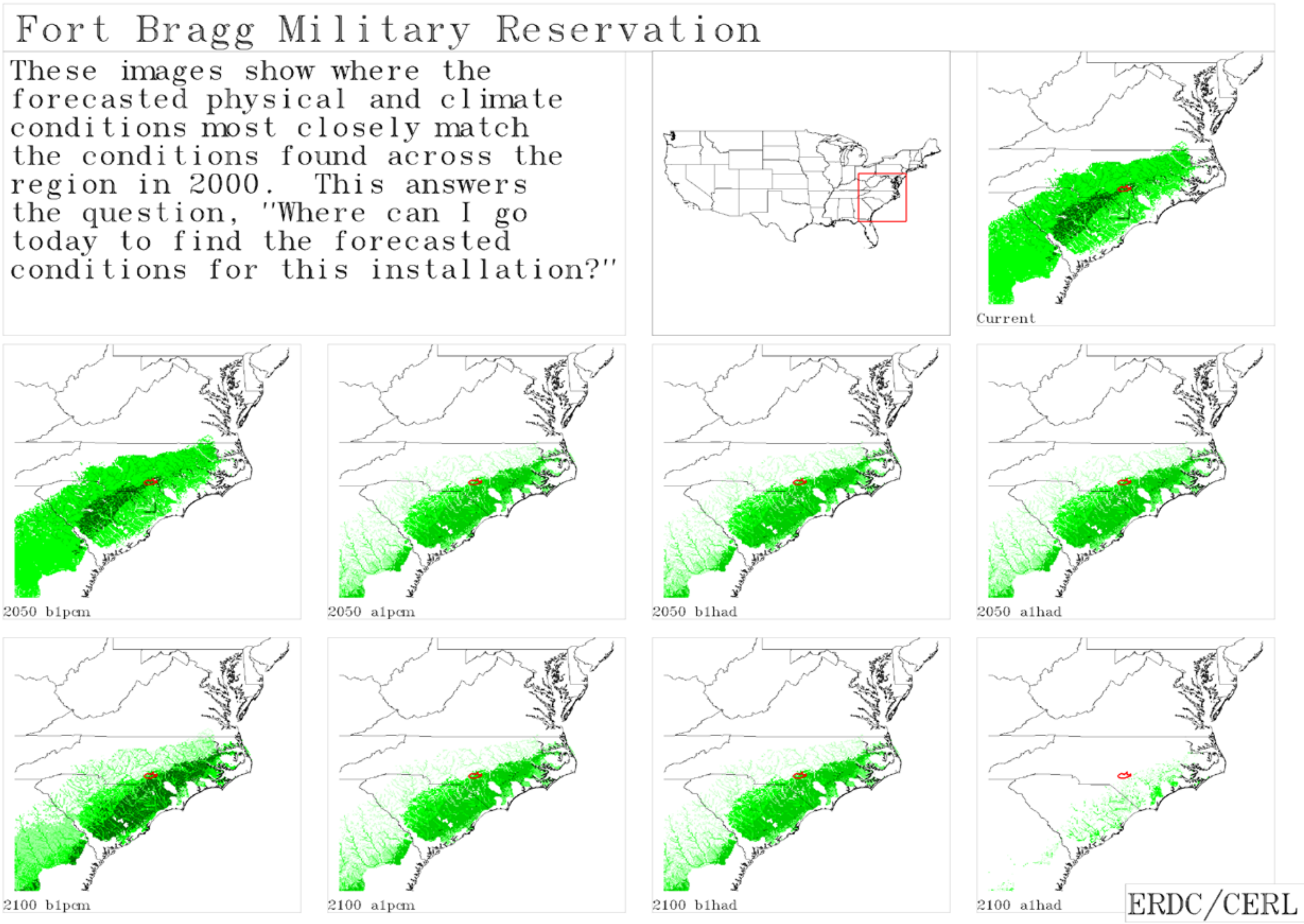

Fort Bliss
0) Different from any area in the world in 2000
93) 43% -Northern Acacia-Commiphora Bushlands And Thickets
145) 96% -Kalahari Xeric Savanna
269) 54% -Southern Shortgrass Prairie
419) 28% -Trans-Mexican Volcanic Belt Pine-Oak Forests
432) 56% -Espinal
434) 37% -Low Monte
448) 37% -High Monte
538) 49% -Central China Loess Plateau Mixed Forests
673) 85% -Baluchistan Xeric Woodlands
693) 64% -Registan-North Pakistan Sandy Desert
703) 55% -Sonoran-Sinaloan Transition Subtropical Dry Forest
704) 49% -Sierra Madre Occidental Pine-Oak Forests
718) 41% -Arizona-New Mexico Mountains
763) 71% -Apache Highlands
765) 30% -Chihuahuan Desert
770) 45% -Sonoran Desert
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



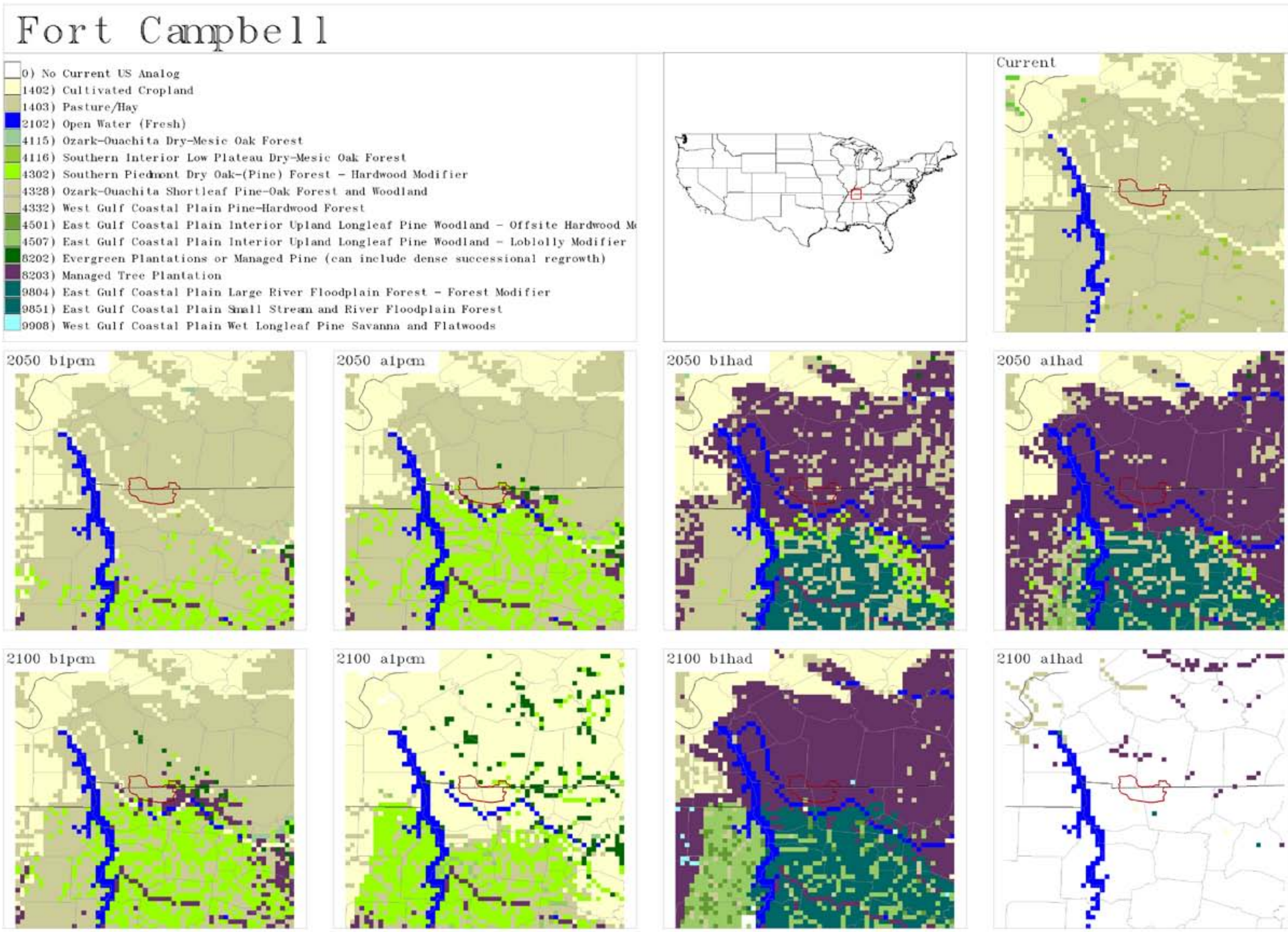
Fort Bragg Military Reservation

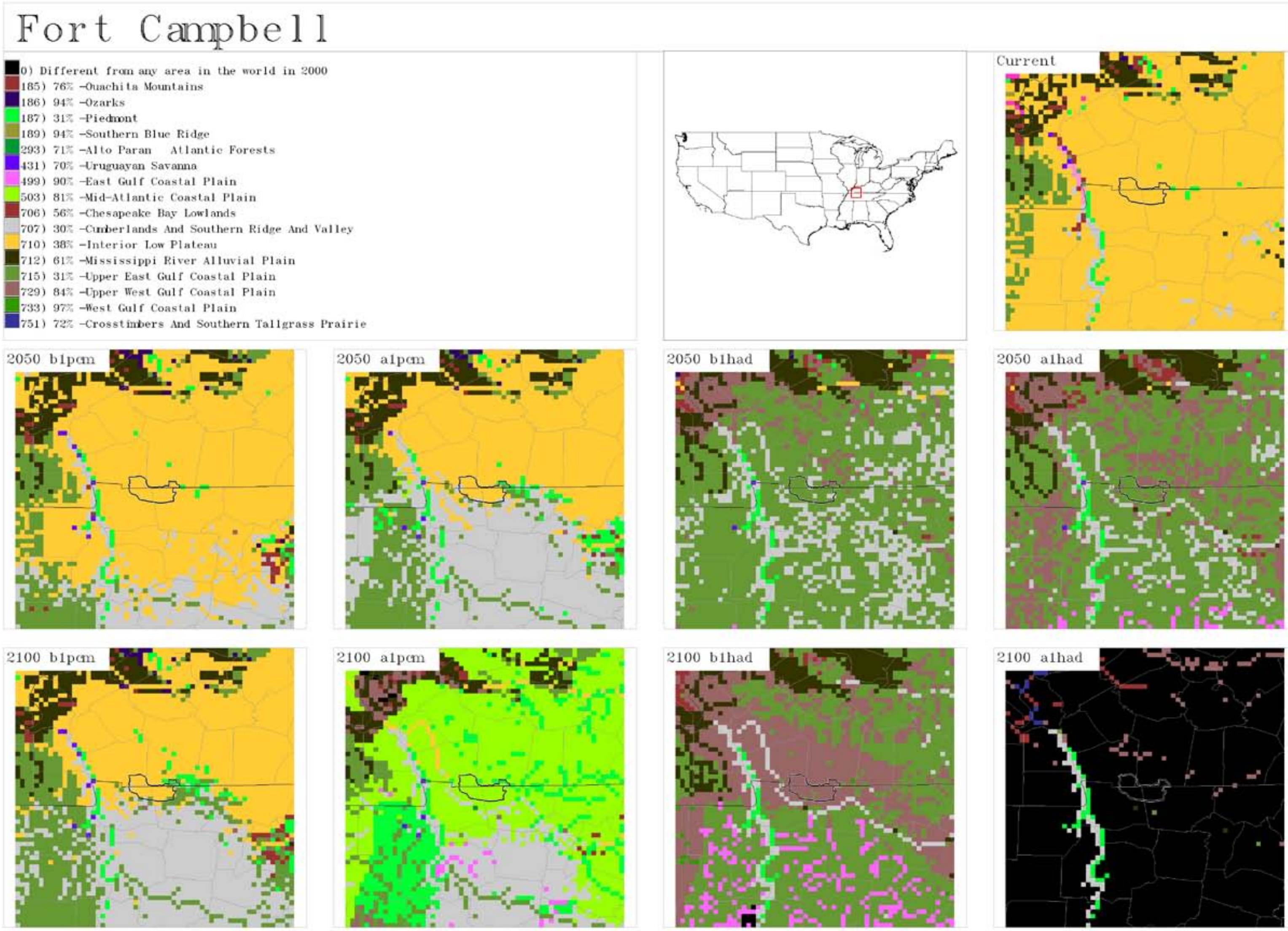

Fort Bragg Military Reservation
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
4115) Ozark-Ouachita Dry-Mesic Oak Forest
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Mo
4328) Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland
4508) East Gulf Coastal Plain Interior Upland Longleaf Pine
8202) Evergreen Plantations or Managed Pine (can include de
9220) Gulf and Atlantic Coastal Plain Tidal Marsh Systems
9804) East Gulf Coastal Plain Large River Floodplain Forest
9903) East Gulf Coastal Plain Near-Coast Pine Flatwoods - O
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

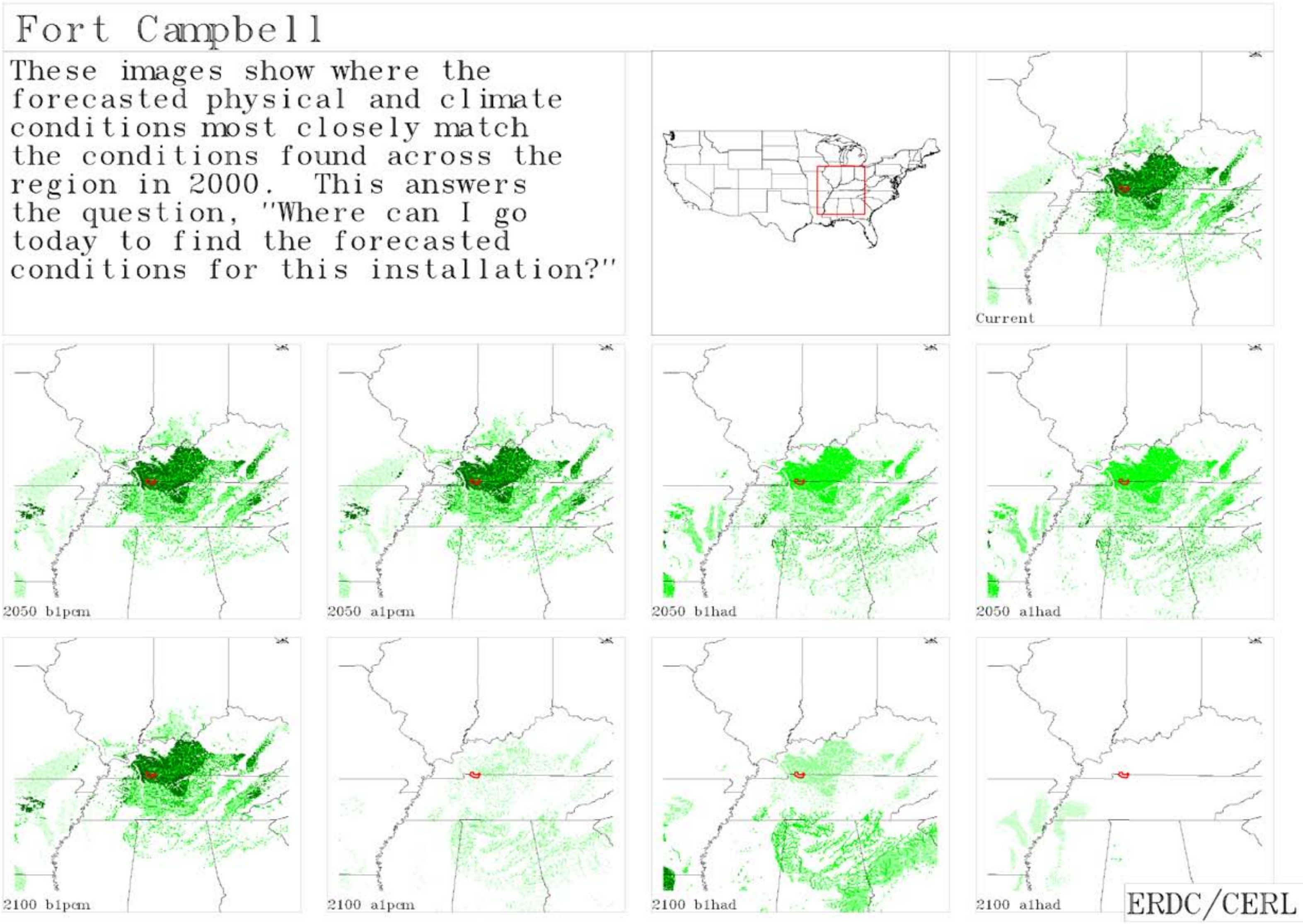

Fort Bragg Military Reservation
0) Different from any area in the world in 2000
185) 76% -Ouachita Mountains
187) 31% -Piedmont
293) 71% -Alto Paran Atlantic Forests
499) 90% -East Gulf Coastal Plain
500) 33% -Florida Peninsula
503) 81% -Mid-Atlantic Coastal Plain
712) 61% -Mississippi River Alluvial Plain
727) 82% -South Atlantic Coastal Plain
746) 100% -Gulf Coast Prairies And Marshes
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



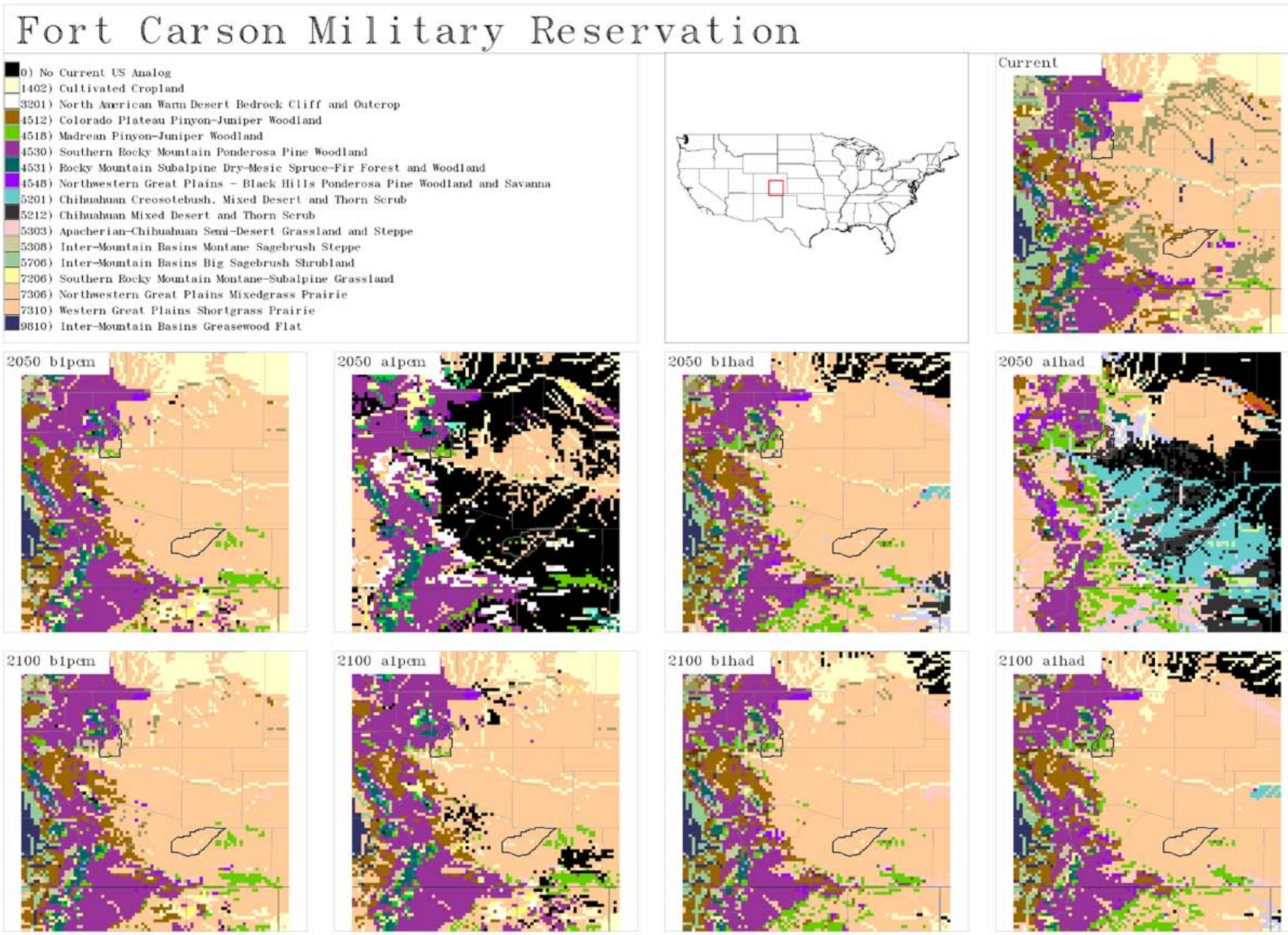
Fort Campbell

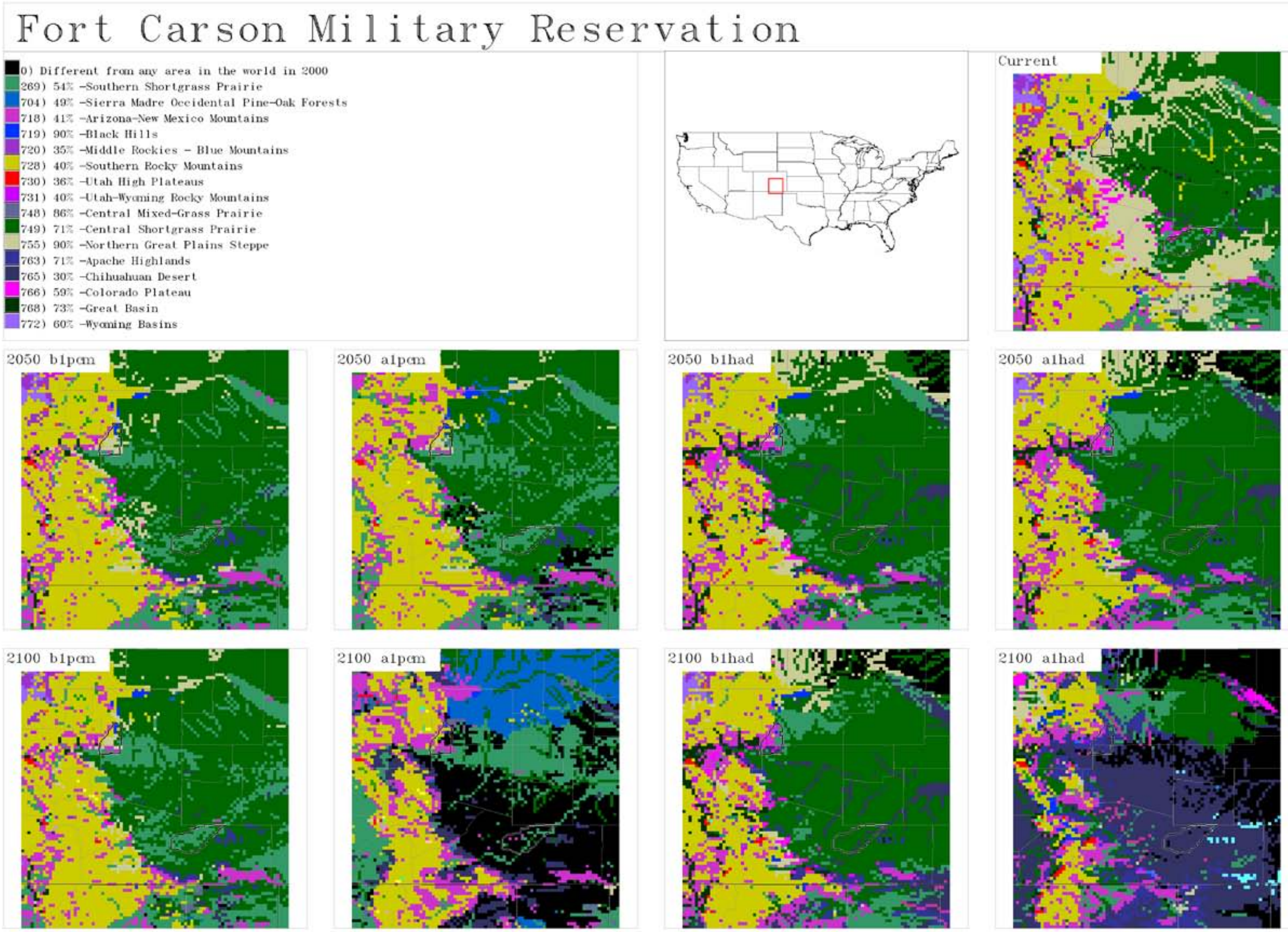

Fort Campbell
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
4115) Ozark-Ouachita Dry-Mesic Oak Forest
4116) Southern Interior Low Plateau Dry-Mesic Oak Forest
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier
4328) Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland
4332) West Gulf Coastal Plain Pine-Hardwood Forest
4501) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Offsite Hardwood M
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Loblolly Modifier
8202) Evergreen Plantations or Managed Pine (can include dense successional regrowth)
8203) Managed Tree Plantation
9804) East Gulf Coastal Plain Large River Floodplain Forest - Forest Modifier
9851) East Gulf Coastal Plain Small Stream and River Floodplain Forest
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

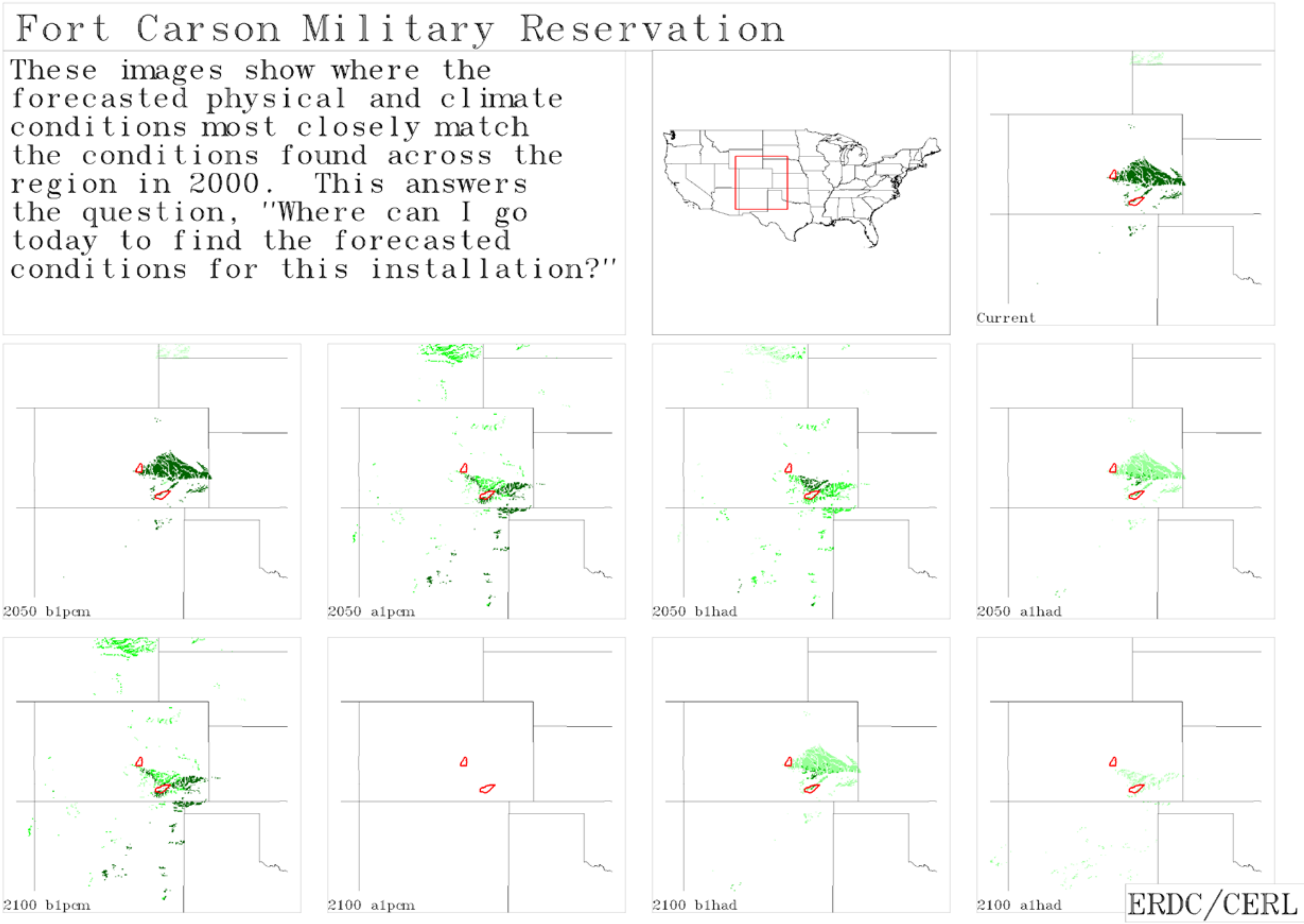

Fort Campbell
0) Different from any area in the world in 2000
185) 76% –Ouachita Mountains
186) 94% –Ozarks
187) 31% –Piedmont
189) 94% –Southern Blue Ridge
293) 71% –Alto Paran Atlantic Forests
431) 70% –Uruguayan Savanna
499) 90% –East Gulf Coastal Plain
503) 81% –Mid-Atlantic Coastal Plain
706) 56% –Chesapeake Bay Lowlands
707) 30% –Cumberlands And Southern Ridge And Valley
710) 38% –Interior Low Plateau
712) 61% –Mississippi River Alluvial Plain
715) 31% –Upper East Gulf Coastal Plain
729) 84% –Upper West Gulf Coastal Plain
733) 97% –West Gulf Coastal Plain
751) 72% –Crosstimbers And Southern Tallgrass Prairie
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



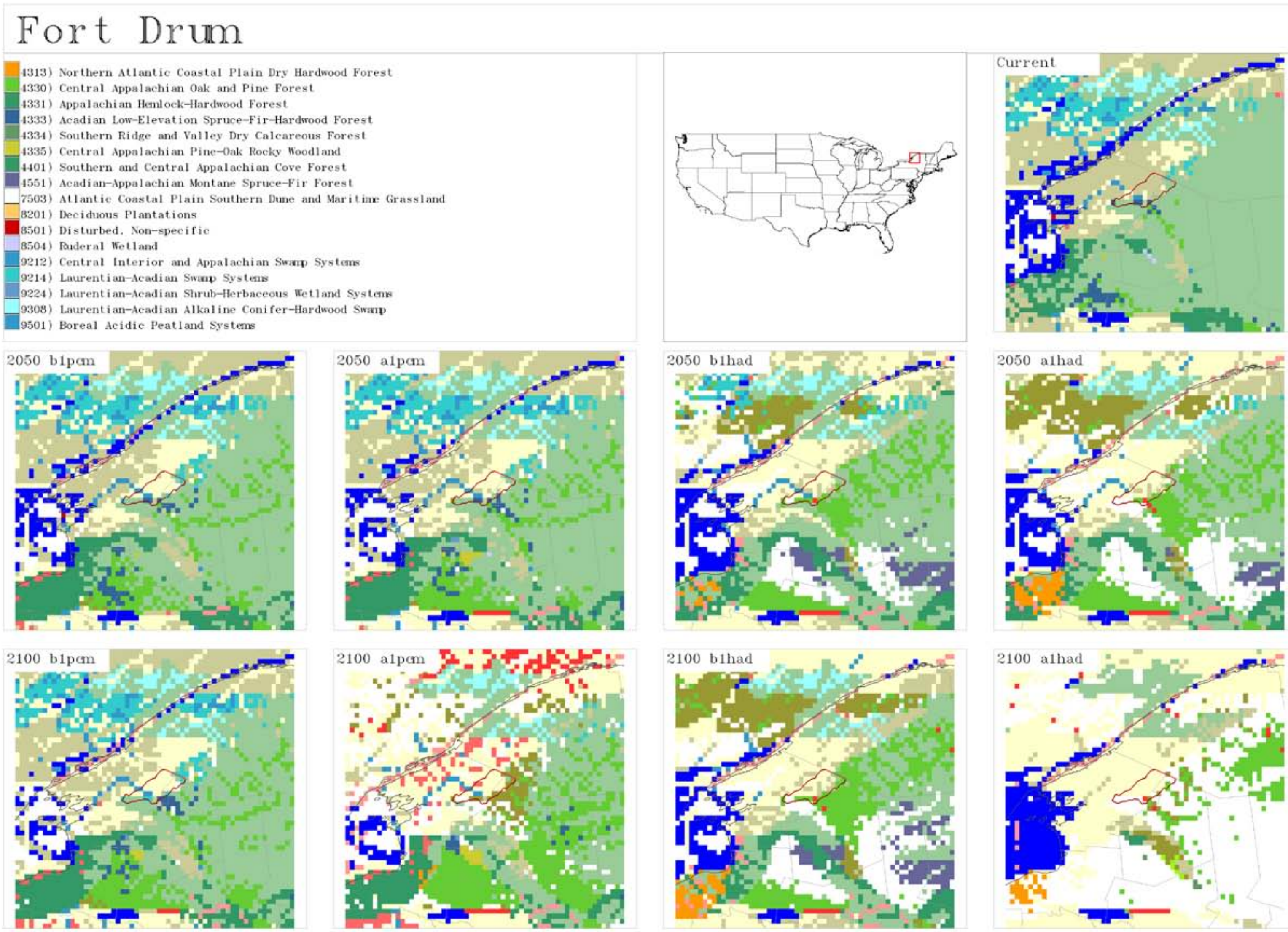
Fort Carson Military Reservation

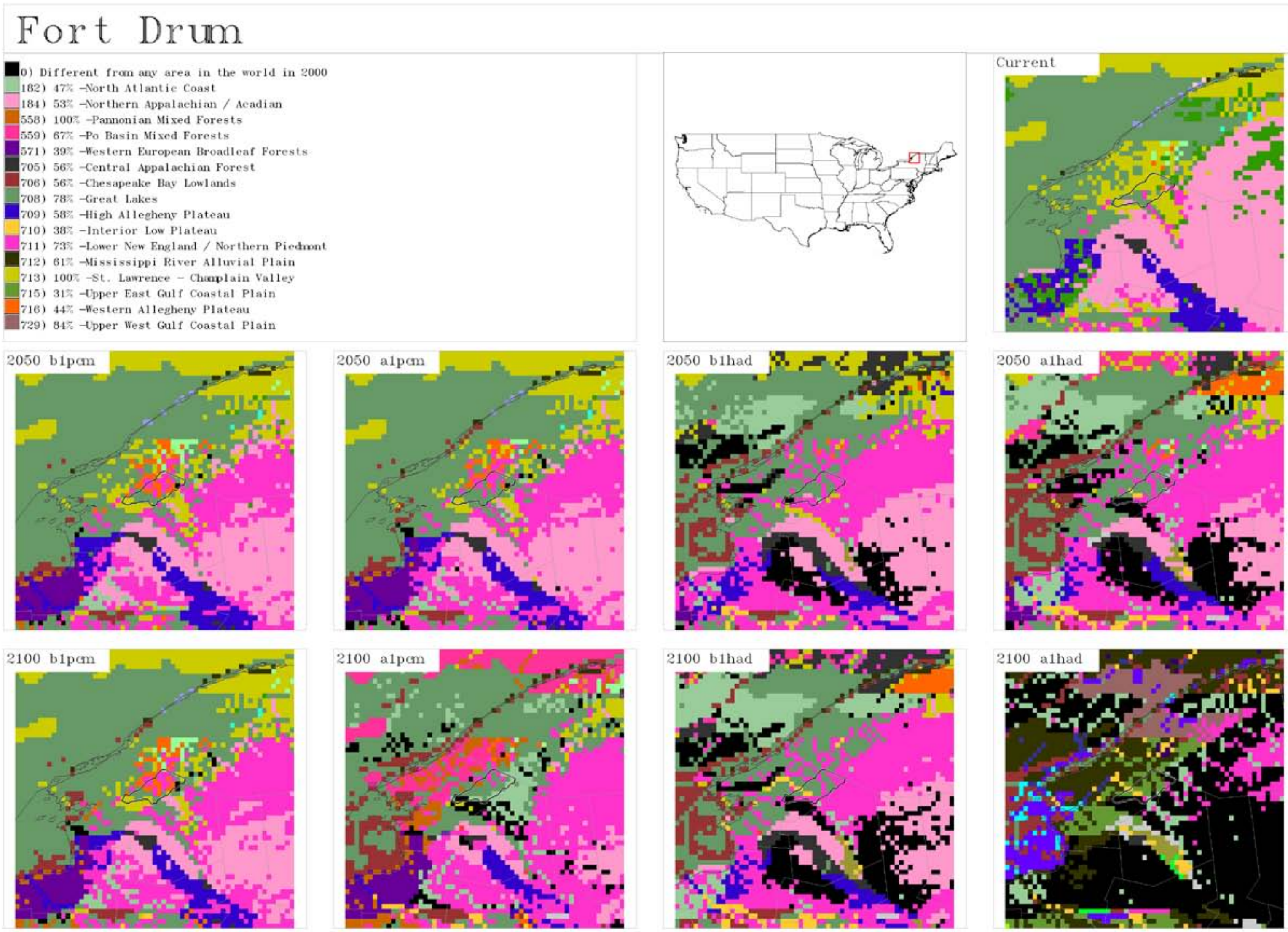

Fort Carson Military Reservation
0) No Current US Analog
1402) Cultivated Cropland
3201) North American Warm Desert Bedrock Cliff and Outcrop
4512) Colorado Plateau Pinyon-Juniper Woodland
4518) Madrean Pinyon-Juniper Woodland
4530) Southern Rocky Mountain Ponderosa Pine Woodland
4531) Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4548) Northwestern Great Plains - Black Hills Ponderosa Pine Woodland and Savanna
5201) Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub
5212) Chihuahuan Mixed Desert and Thorn Scrub
5303) Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5308) Inter-Mountain Basins Montane Sagebrush Steppe
5706) Inter-Mountain Basins Big Sagebrush Shrubland
7206) Southern Rocky Mountain Montane-Subalpine Grassland
7306) Northwestern Great Plains Mixedgrass Prairie
7310) Western Great Plains Shortgrass Prairie
9810) Inter-Mountain Basins Greasewood Flat
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

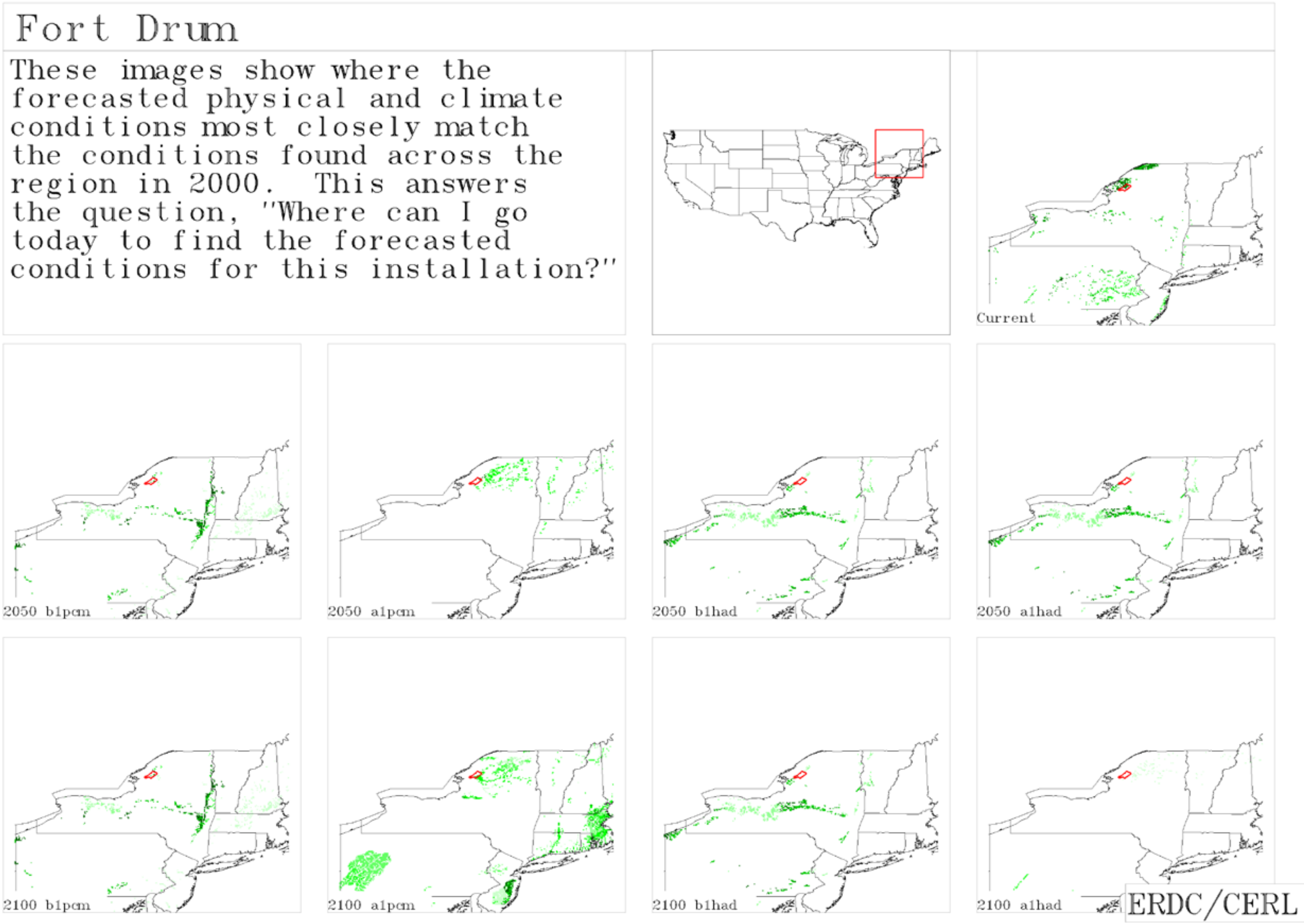

Fort Carson Military Reservation
0) Different from any area in the world in 2000
269) 54% –Southern Shortgrass Prairie
704) 49% –Sierra Madre Occidental Pine-Oak Forests
718) 41% –Arizona-New Mexico Mountains
719) 90% –Black Hills
720) 35% –Middle Rockies – Blue Mountains
728) 40% –Southern Rocky Mountains
730) 36% –Utah High Plateaus
731) 40% –Utah-Wyoming Rocky Mountains
748) 86% –Central Mixed-Grass Prairie
749) 71% –Central Shortgrass Prairie
755) 90% –Northern Great Plains Steppe
763) 71% –Apache Highlands
765) 30% –Chihuahuan Desert
766) 59% –Colorado Plateau
768) 73% –Great Basin
772) 60% –Wyoming Basins
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Fort Carson Military Reservation
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

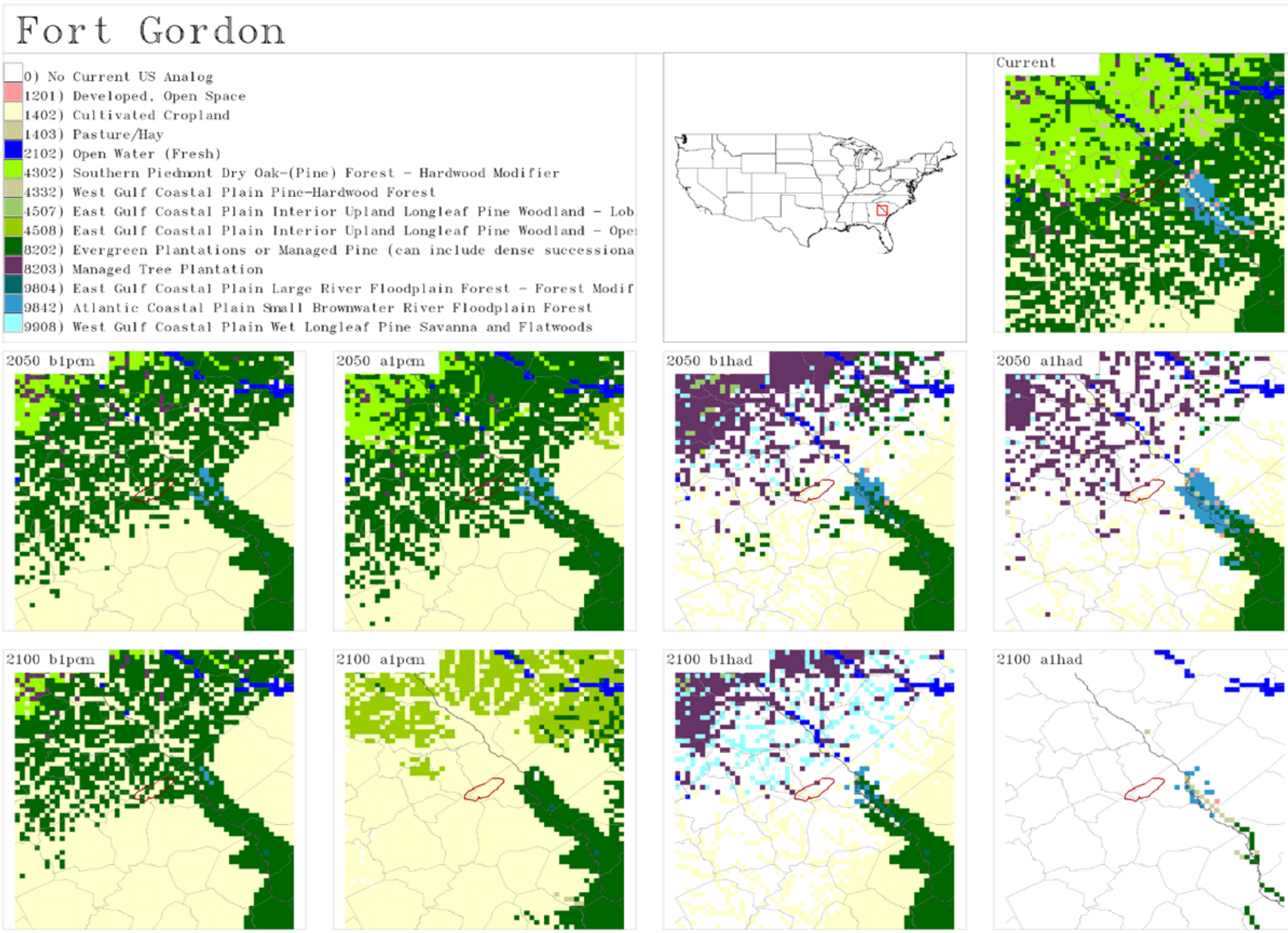
Fort Drum

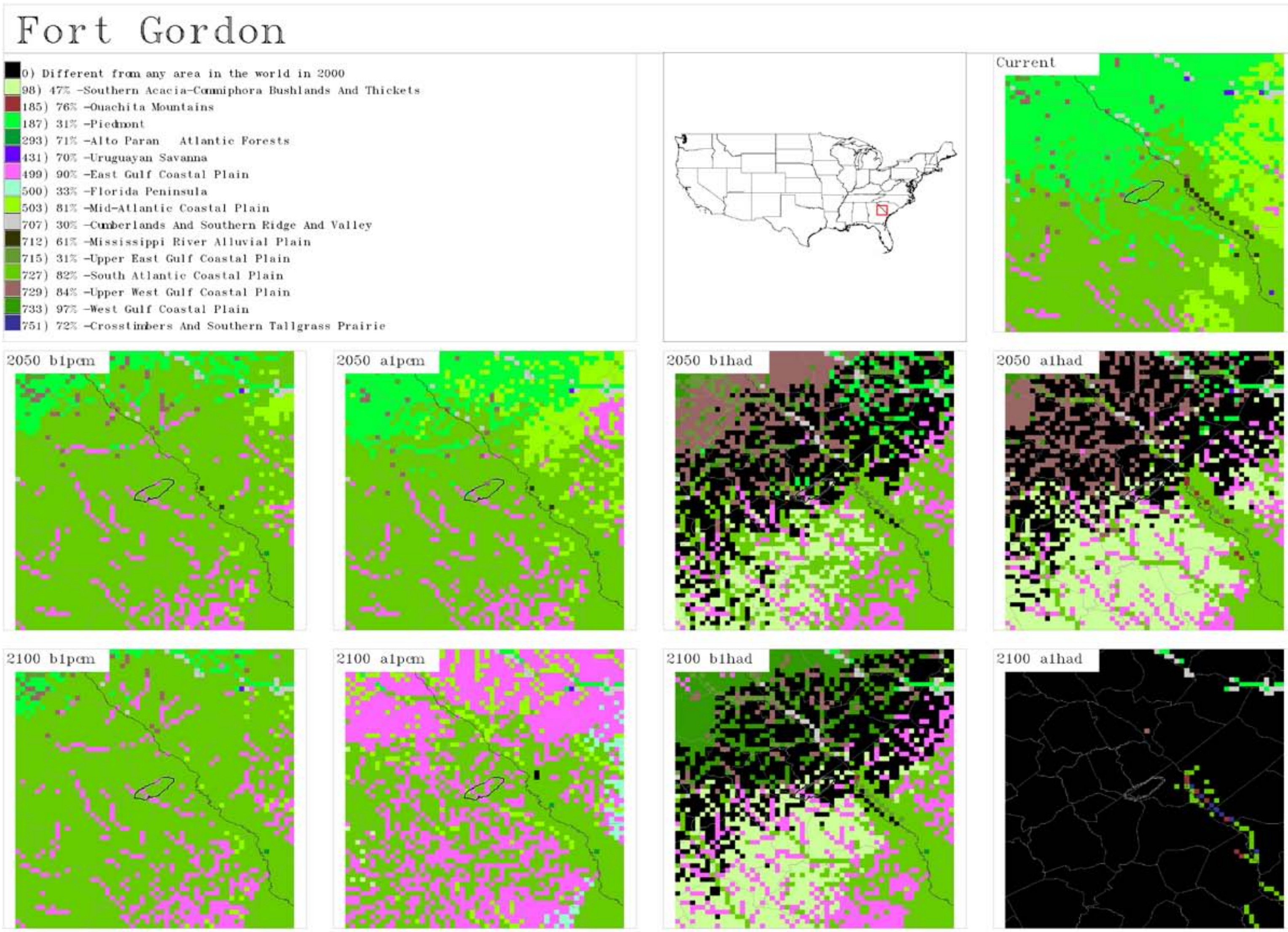

Fort Drum
4313) Northern Atlantic Coastal Plain Dry Hardwood Forest
4330) Central Appalachian Oak and Pine Forest
4331) Appalachian Hemlock-Hardwood Forest
4333) Acadian Low-Elevation Spruce-Fir-Hardwood Forest
4334) Southern Ridge and Valley Dry Calcareous Forest
4335) Central Appalachian Pine-Oak Rocky Woodland
4401) Southern and Central Appalachian Cove Forest
4551) Acadian-Appalachian Montane Spruce-Fir Forest
7503) Atlantic Coastal Plain Southern Dune and Maritime Grassland
8201) Deciduous Plantations
8501) Disturbed, Non-specific
8504) Ruderal Wetland
9212) Central Interior and Appalachian Swamp Systems
9214) Laurentian-Acadian Swamp Systems
9224) Laurentian-Acadian Shrub-Herbaceous Wetland Systems
9308) Laurentian-Acadian Alkaline Conifer-Hardwood Swamp
9501) Boreal Acidic Peatland Systems
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

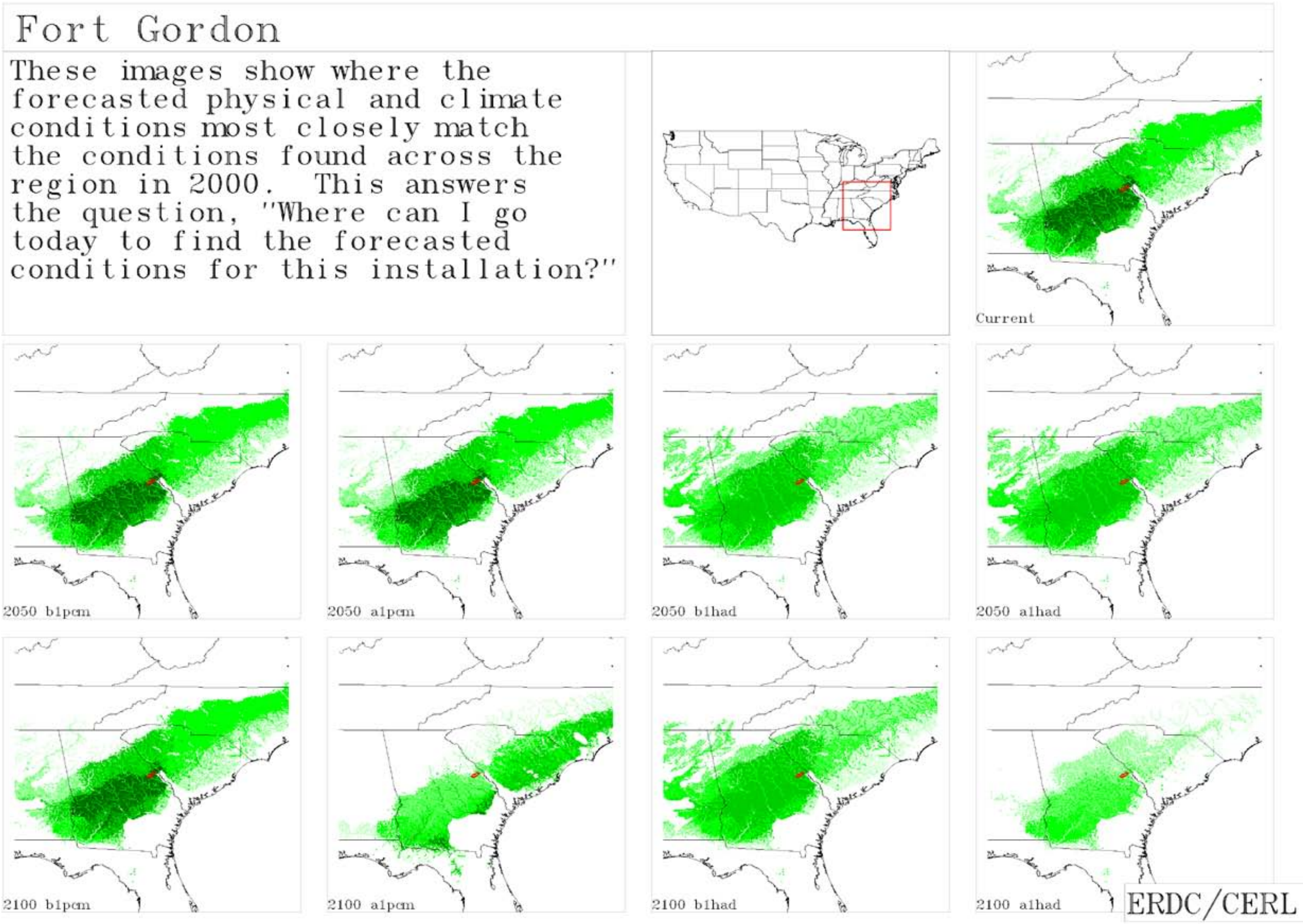

Fort Drum
0) Different from any area in the world in 2000
182) 47% -North Atlantic Coast
184) 53% -Northern Appalachian / Acadian
558) 100% -Pannonian Mixed Forests
559) 67% -Po Basin Mixed Forests
571) 39% -Western European Broadleaf Forests
705) 56% -Central Appalachian Forest
706) 56% -Chesapeake Bay Lowlands
708) 78% -Great Lakes
709) 58% -High Allegheny Plateau
710) 38% -Interior Low Plateau
711) 73% -Lower New England / Northern Piedmont
712) 61% -Mississippi River Alluvial Plain
713) 100% -St. Lawrence - Champlain Valley
715) 31% -Upper East Gulf Coastal Plain
716) 44% -Western Allegheny Plateau
729) 84% -Upper West Gulf Coastal Plain
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Fort Drum
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

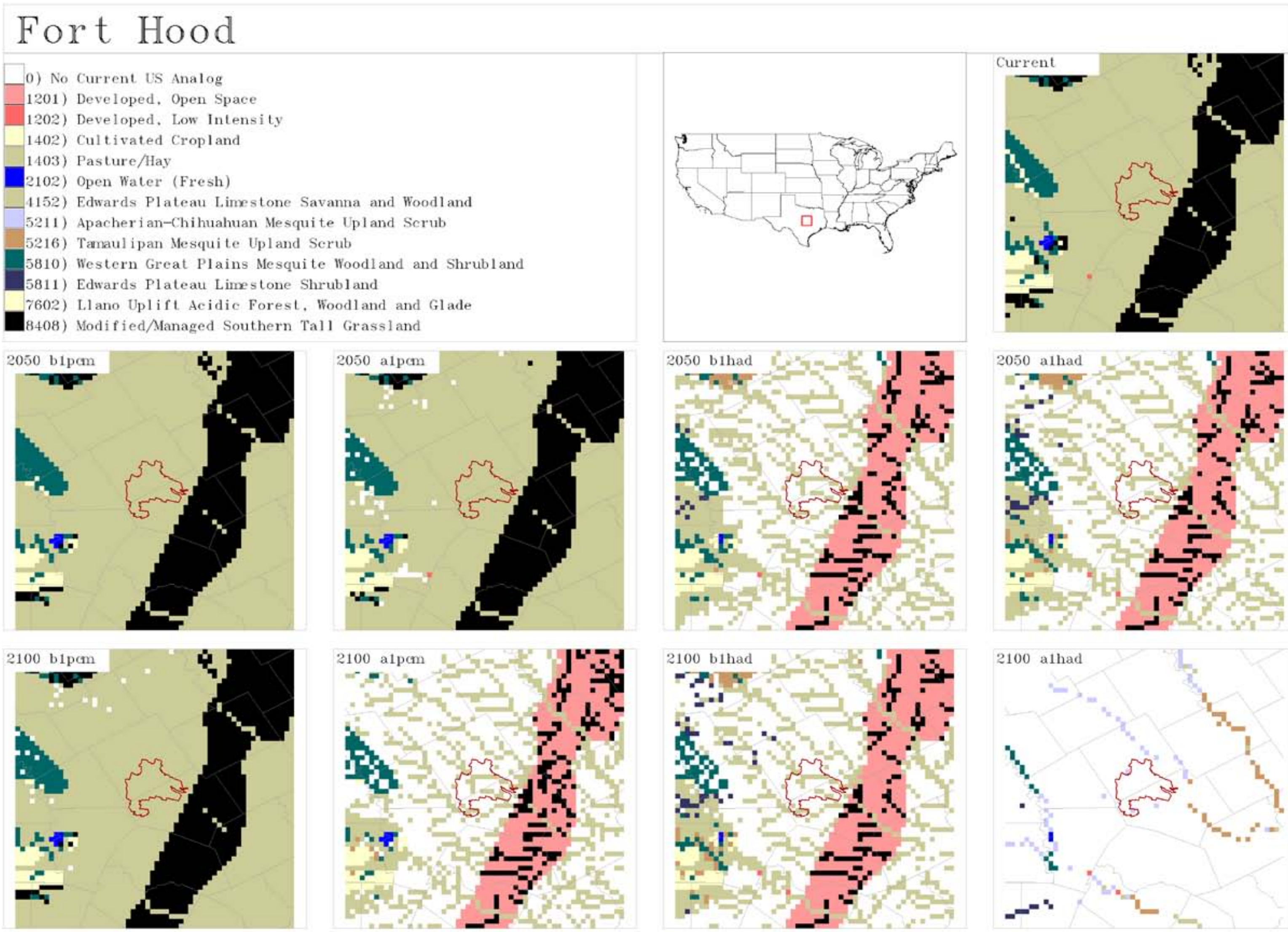
Fort Gordon


Fort Gordon
0) No Current US Analog
1201) Developed, Open Space
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier
4332) West Gulf Coastal Plain Pine-Hardwood Forest
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Lob
4508) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Ope
8202) Evergreen Plantations or Managed Pine (can include dense successiona
8203) Managed Tree Plantation
9804) East Gulf Coastal Plain Large River Floodplain Forest - Forest Modif
9842) Atlantic Coastal Plain Small Brownwater River Floodplain Forest
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

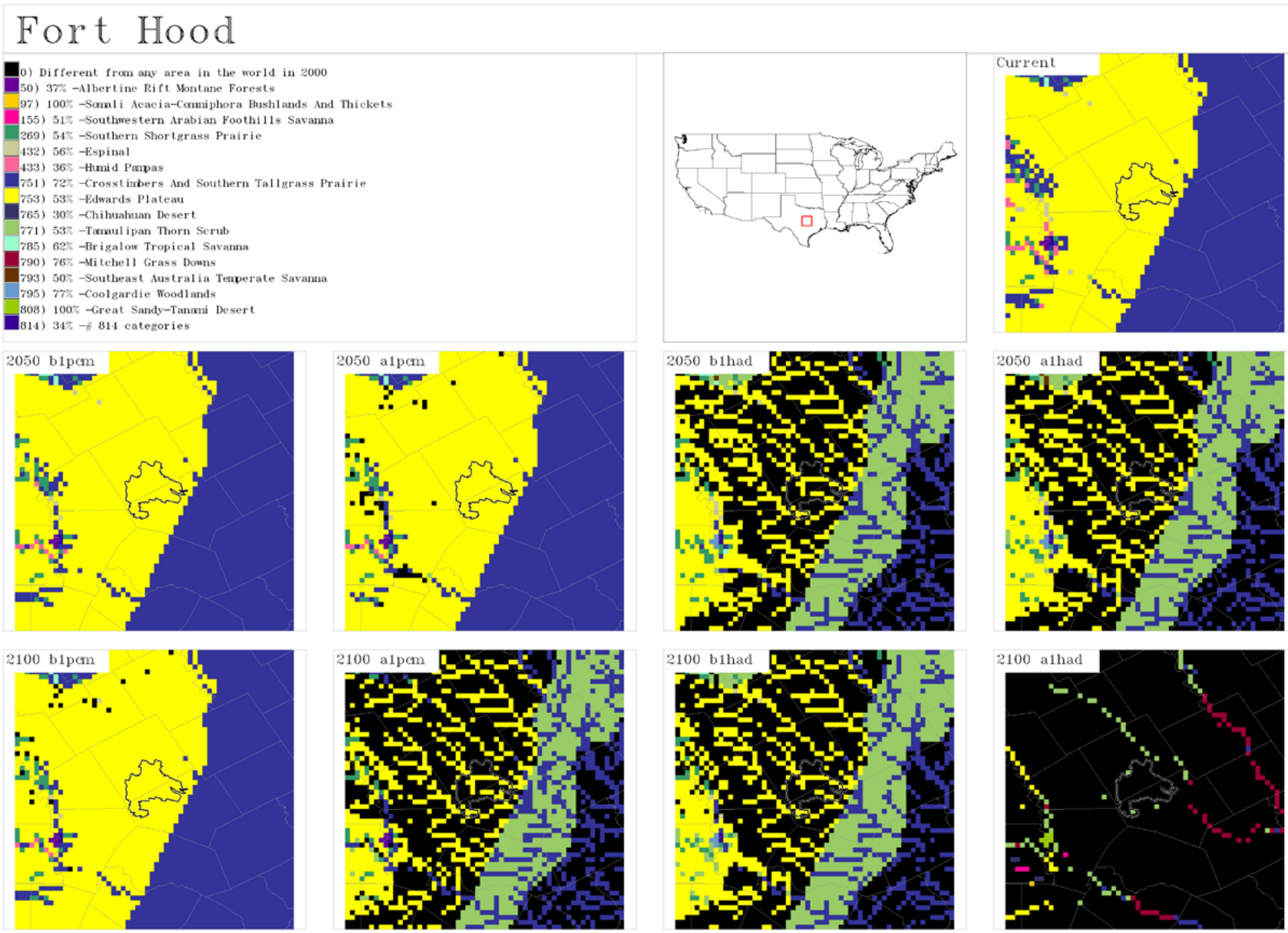

Fort Gordon
0) Different from any area in the world in 2000
98) 47% -Southern Acacia-Commiphora Bushlands And Thickets
185) 76% -Ouachita Mountains
187) 31% -Piedmont
293) 71% -Alto Paran Atlantic Forests
431) 70% -Uruguayan Savanna
499) 90% -East Gulf Coastal Plain
500) 33% -Florida Peninsula
503) 81% -Mid-Atlantic Coastal Plain
707) 30% -Cumberlands And Southern Ridge And Valley
712) 61% -Mississippi River Alluvial Plain
715) 31% -Upper East Gulf Coastal Plain
727) 82% -South Atlantic Coastal Plain
729) 84% -Upper West Gulf Coastal Plain
733) 97% -West Gulf Coastal Plain
751) 72% -Crosstimbers And Southern Tallgrass Prairie
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

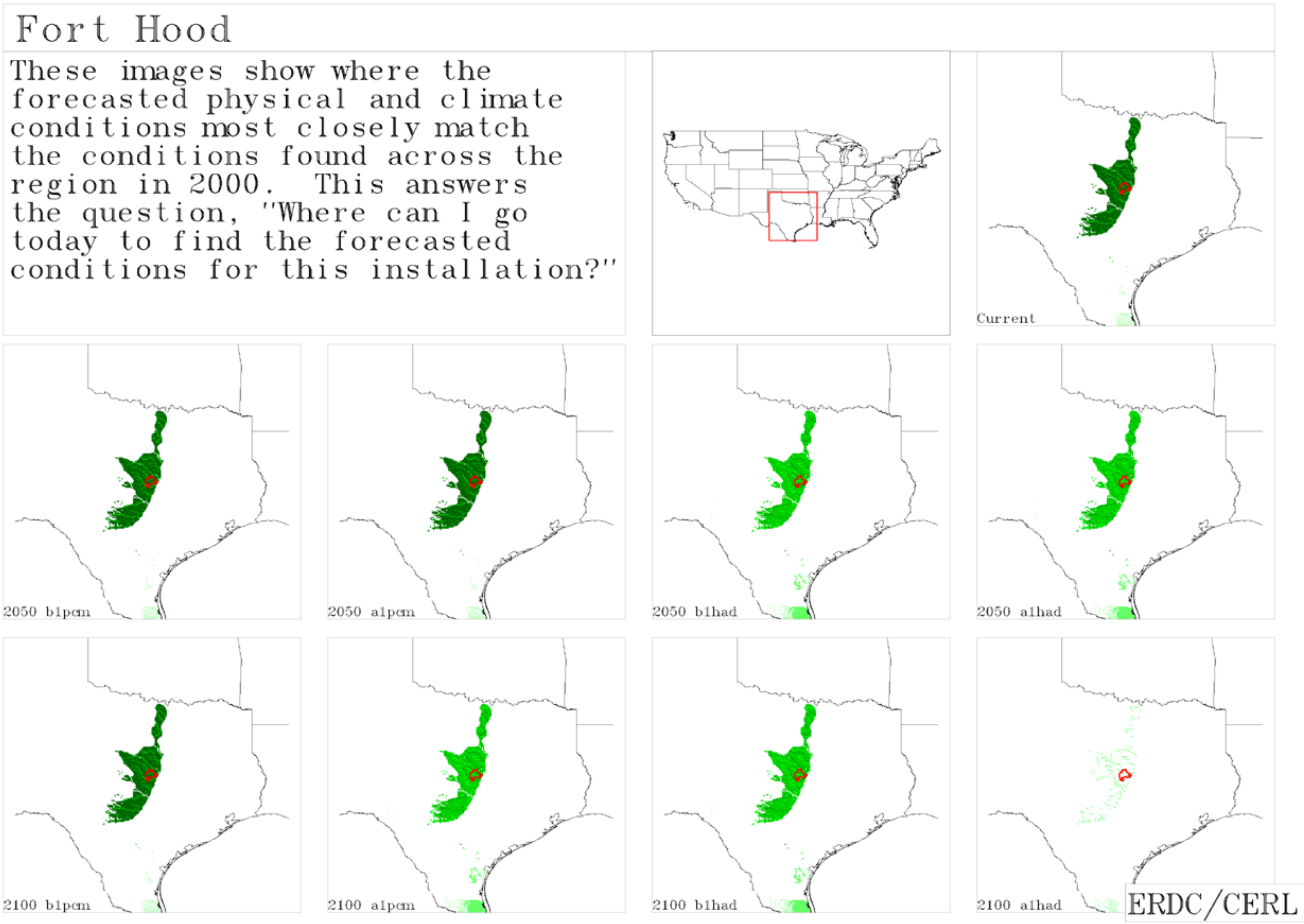

Fort Gordon
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

Fort Hood

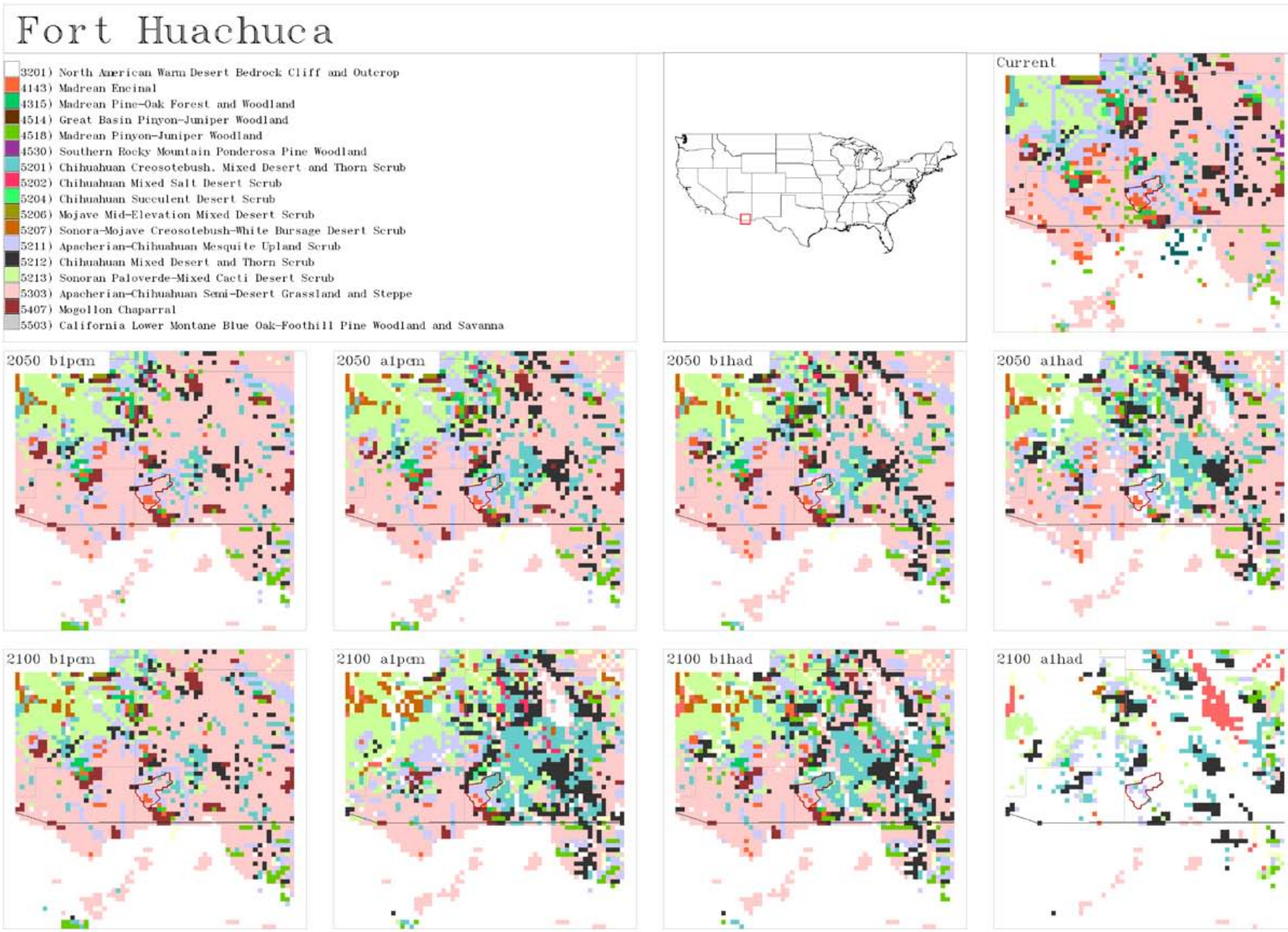


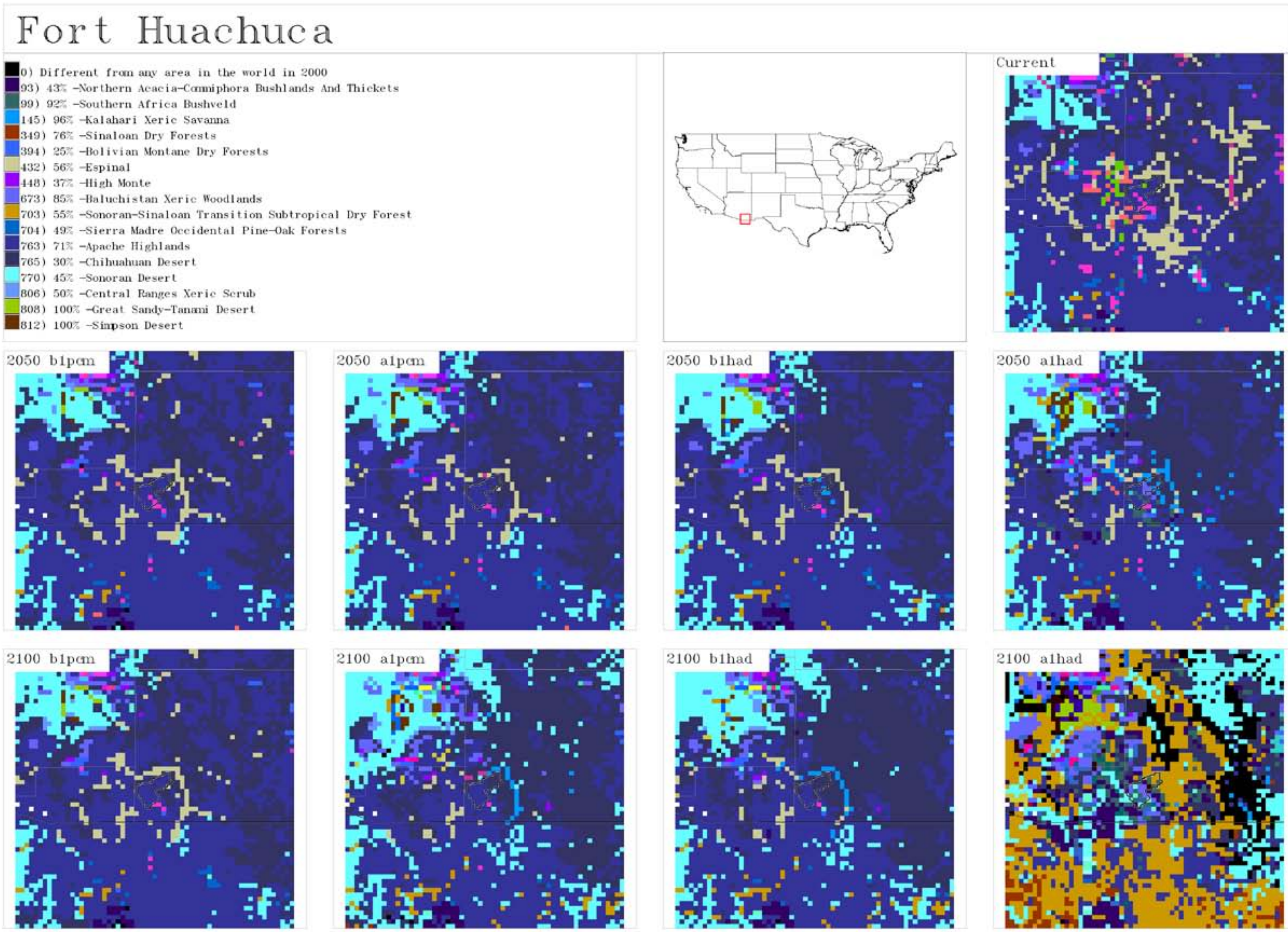
Fort Hood
0) No Current US Analog
1201) Developed, Open Space
1202) Developed, Low Intensity
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
4152) Edwards Plateau Limestone Savanna and Woodland
5211) Apacherian-Chihuahuan Mesquite Upland Scrub
5216) Tamaulipan Mesquite Upland Scrub
5810) Western Great Plains Mesquite Woodland and Shrubland
5811) Edwards Plateau Limestone Shrubland
7602) Llano Uplift Acidic Forest, Woodland and Glade
8408) Modified/Managed Southern Tall Grassland
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

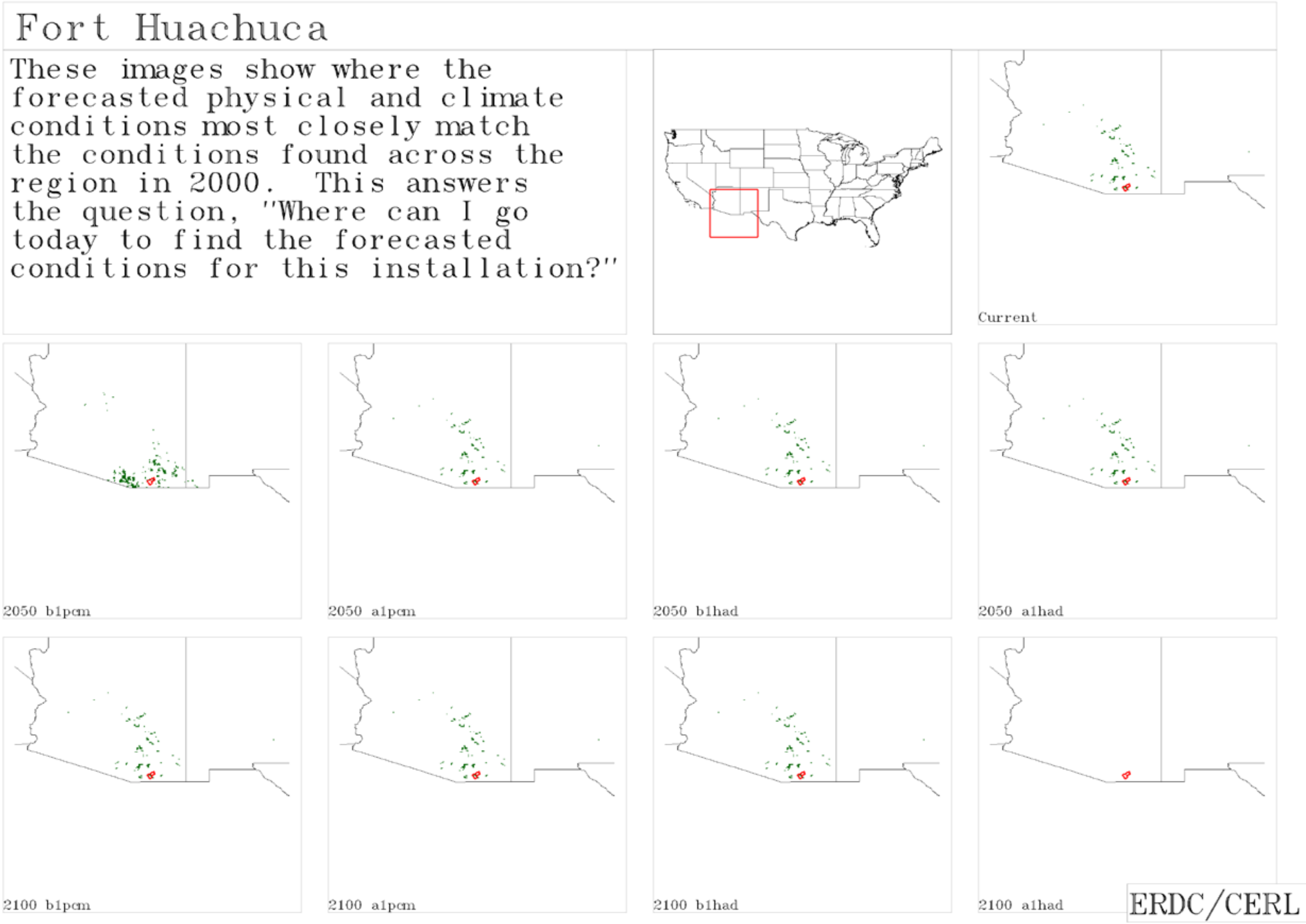

Fort Hood
0) Different from any area in the world in 2000
50) 37% -Albertine Rift Montane Forests
97) 100% -Somali Acacia-Commiphora Bushlands And Thickets
155) 51% -Southwestern Arabian Foothills Savanna
269) 54% -Southern Shortgrass Prairie
432) 56% -Espinal
433) 36% -Humid Pampas
751) 72% -Crosstimbers And Southern Tallgrass Prairie
753) 53% -Edwards Plateau
765) 30% -Chihuahuan Desert
771) 53% -Tamaulipan Thorn Scrub
785) 62% -Brigalow Tropical Savanna
790) 76% -Mitchell Grass Downs
793) 50% -Southeast Australia Temperate Savanna
795) 77% -Coolgardie Woodlands
808) 100% -Great Sandy-Tanami Desert
814) 34% -# 814 categories
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



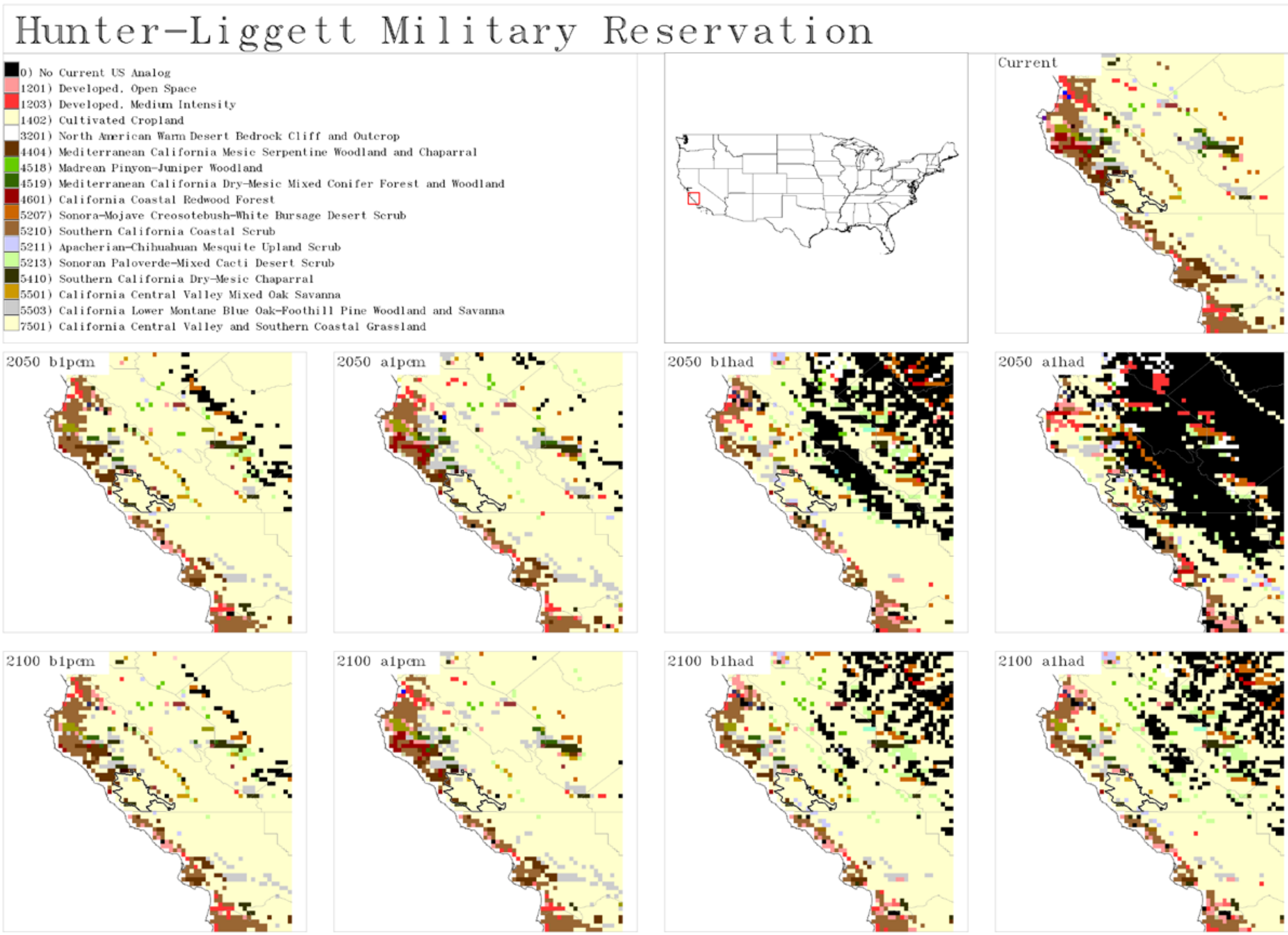
Fort Huachuca

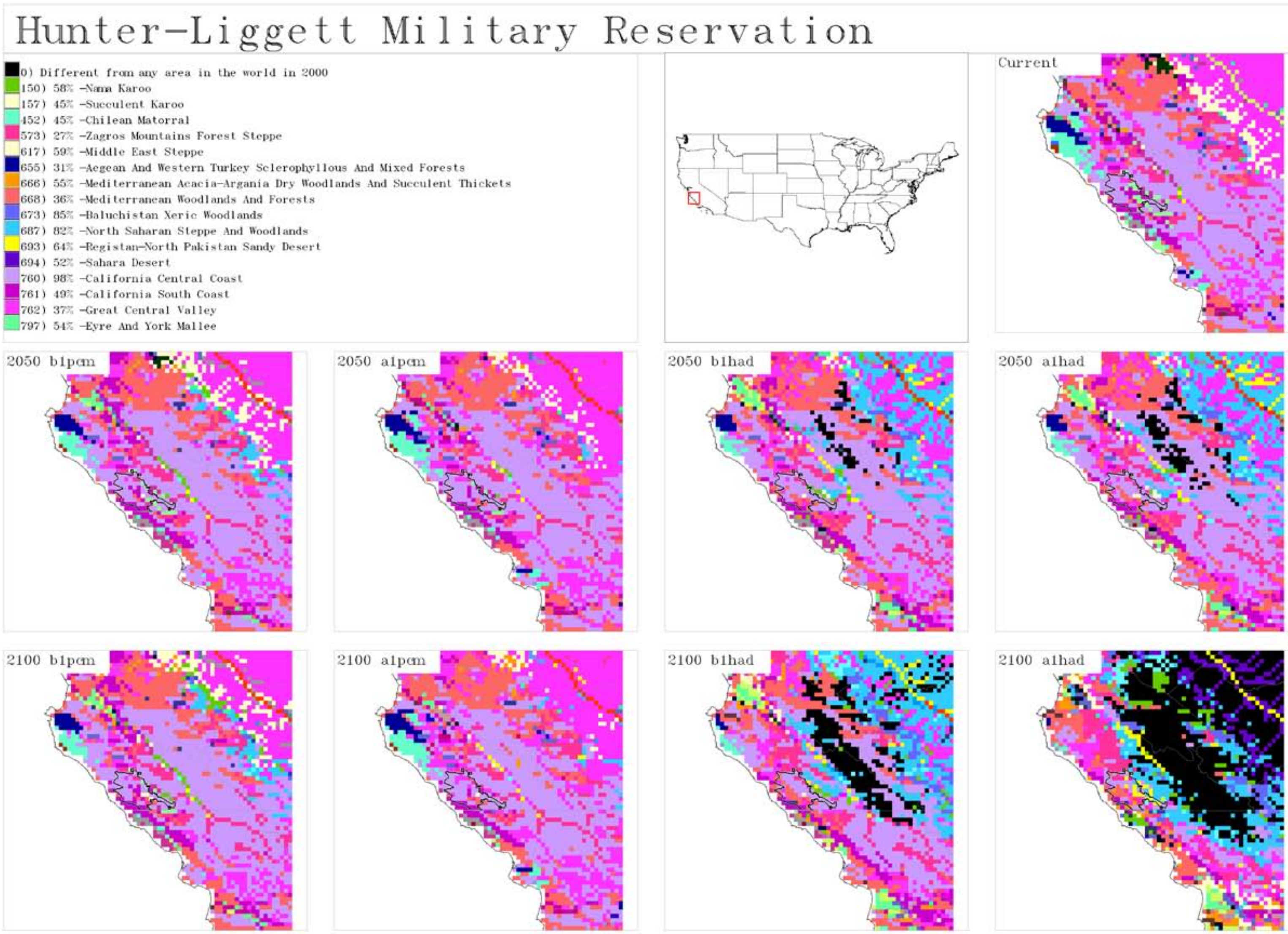

Fort Huachuca
3201) North American Warm Desert Bedrock Cliff and Outcrop
4143) Madrean Encinal
4315) Madrean Pine-Oak Forest and Woodland
4514) Great Basin Pinyon-Juniper Woodland
4518) Madrean Pinyon-Juniper Woodland
4530) Southern Rocky Mountain Ponderosa Pine Woodland
5201) Chihuahuan Creosotebush, Mixed Desert and Thorn Scrub
5202) Chihuahuan Mixed Salt Desert Scrub
5204) Chihuahuan Succulent Desert Scrub
5206) Mojave Mid-Elevation Mixed Desert Scrub
5207) Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5211) Apacherian-Chihuahuan Mesquite Upland Scrub
5212) Chihuahuan Mixed Desert and Thorn Scrub
5213) Sonoran Paloverde-Mixed Cacti Desert Scrub
5303) Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5407) Mogollon Chaparral
5503) California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

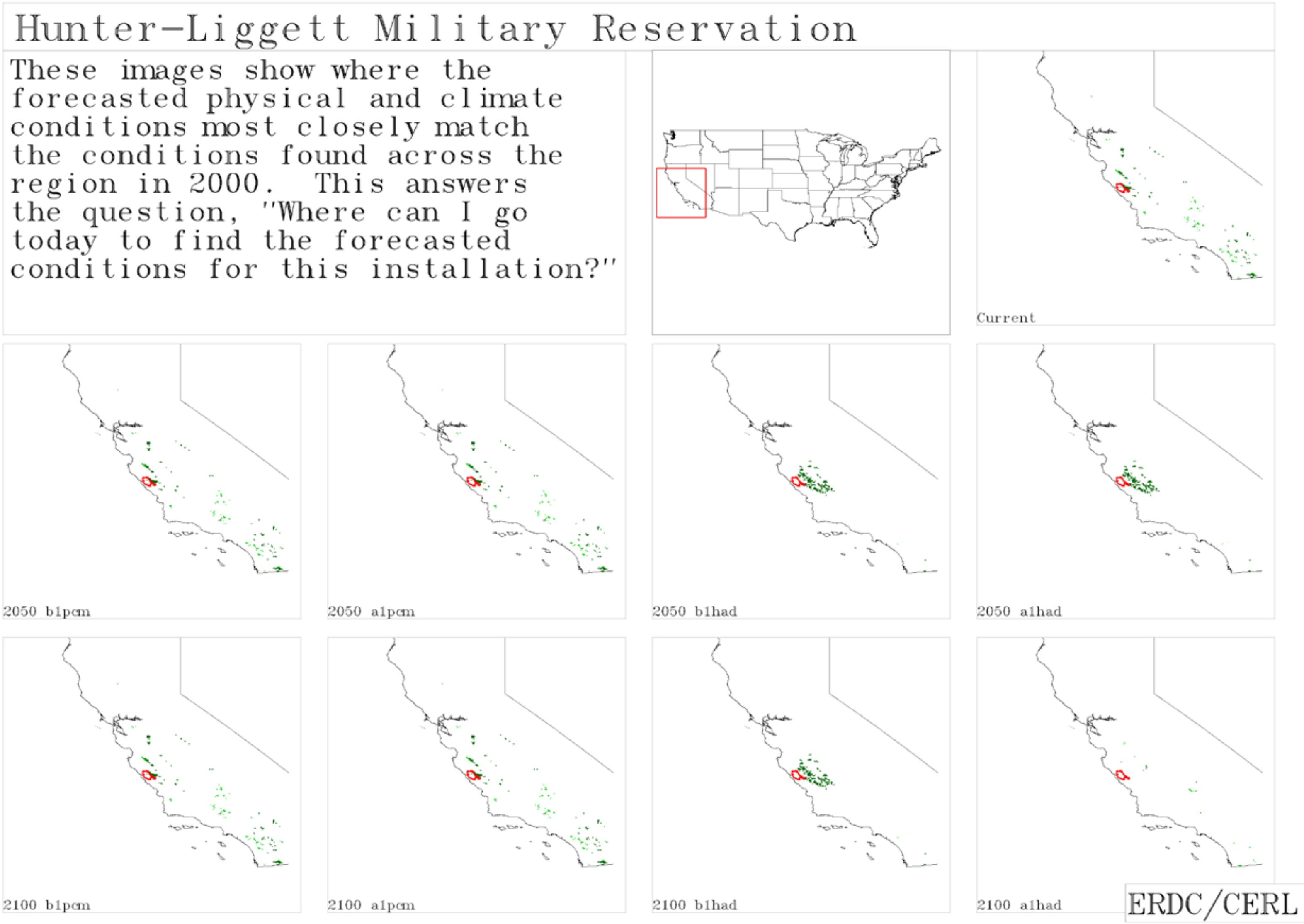

Fort Huachuca
0) Different from any area in the world in 2000
93) 43% -Northern Acacia-Commiphora Bushlands And Thickets
99) 92% -Southern Africa Bushveld
145) 96% -Kalahari Xeric Savanna
349) 76% -Sinaloan Dry Forests
394) 25% -Bolivian Montane Dry Forests
432) 56% -Espinal
448) 37% -High Monte
673) 85% -Baluchistan Xeric Woodlands
703) 55% -Sonoran-Sinaloan Transition Subtropical Dry Forest
704) 49% -Sierra Madre Occidental Pine-Oak Forests
763) 71% -Apache Highlands
765) 30% -Chihuahuan Desert
770) 45% -Sonoran Desert
806) 50% -Central Ranges Xeric Scrub
808) 100% -Great Sandy-Tanami Desert
812) 100% -Simpson Desert
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



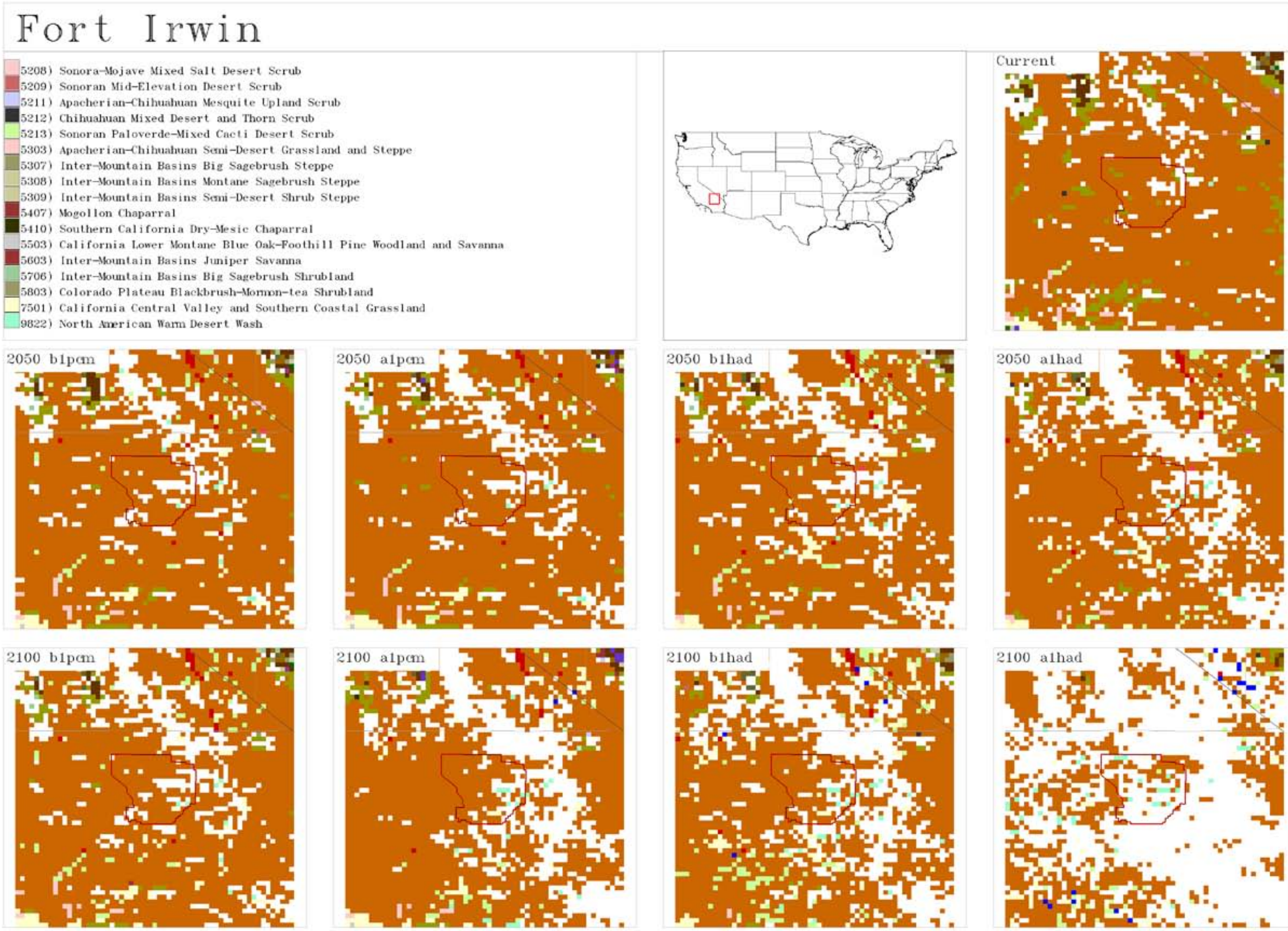
Hunter-Liggett Military Reservation

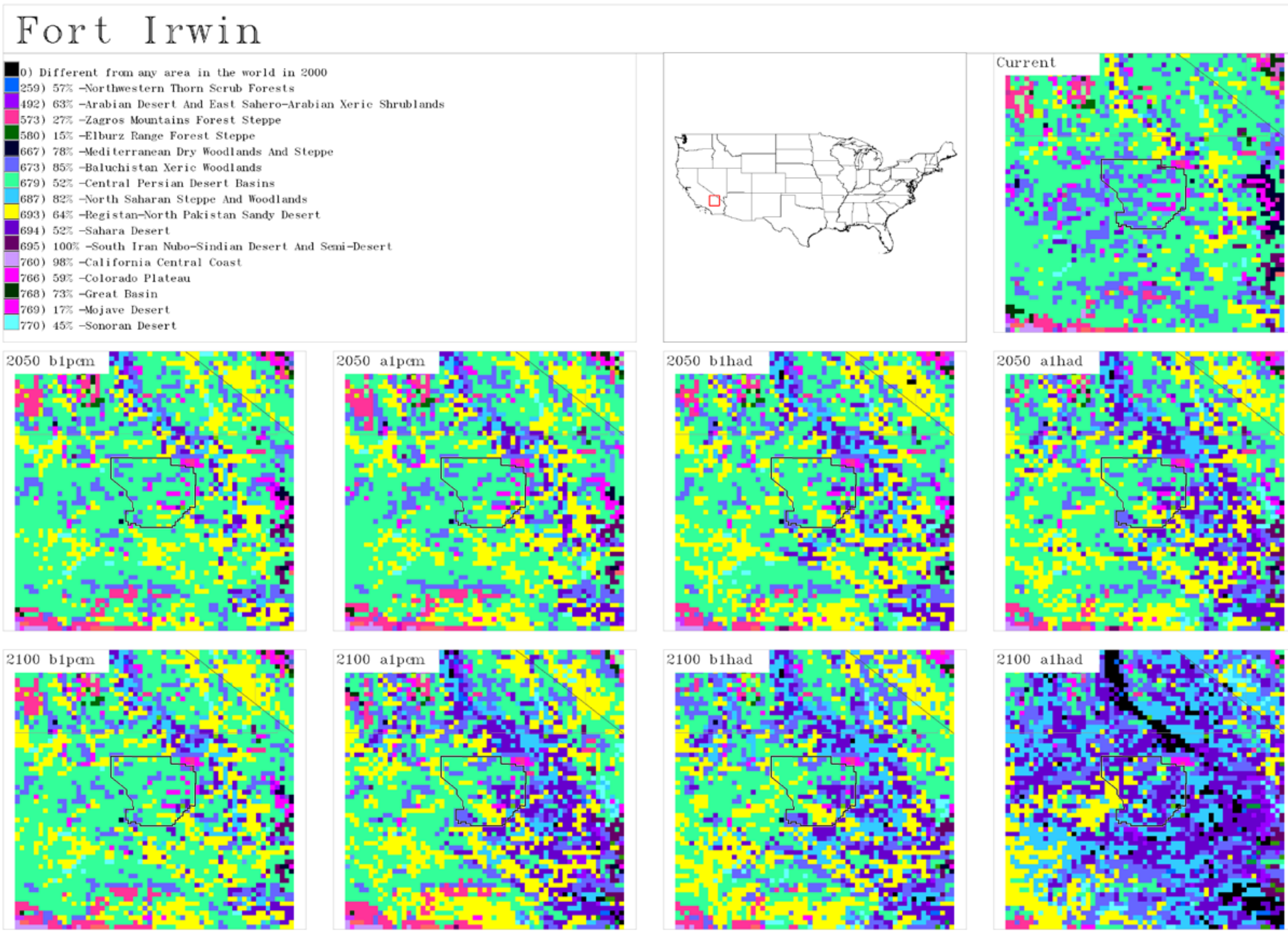

Hunter-Liggett Military Reservation
0) No Current US Analog
1201) Developed, Open Space
1203) Developed, Medium Intensity
1402) Cultivated Cropland
3201) North American Warm Desert Bedrock Cliff and Outcrop
4404) Mediterranean California Mesic Serpentine Woodland and Chaparral
4518) Madrean Pinyon-Juniper Woodland
4519) Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
4601) California Coastal Redwood Forest
5207) Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5210) Southern California Coastal Scrub
5211) Apacherian-Chihuahuan Mesquite Upland Scrub
5213) Sonoran Paloverde-Mixed Cacti Desert Scrub
5410) Southern California Dry-Mesic Chaparral
5501) California Central Valley Mixed Oak Savanna
5503) California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna
7501) California Central Valley and Southern Coastal Grassland
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

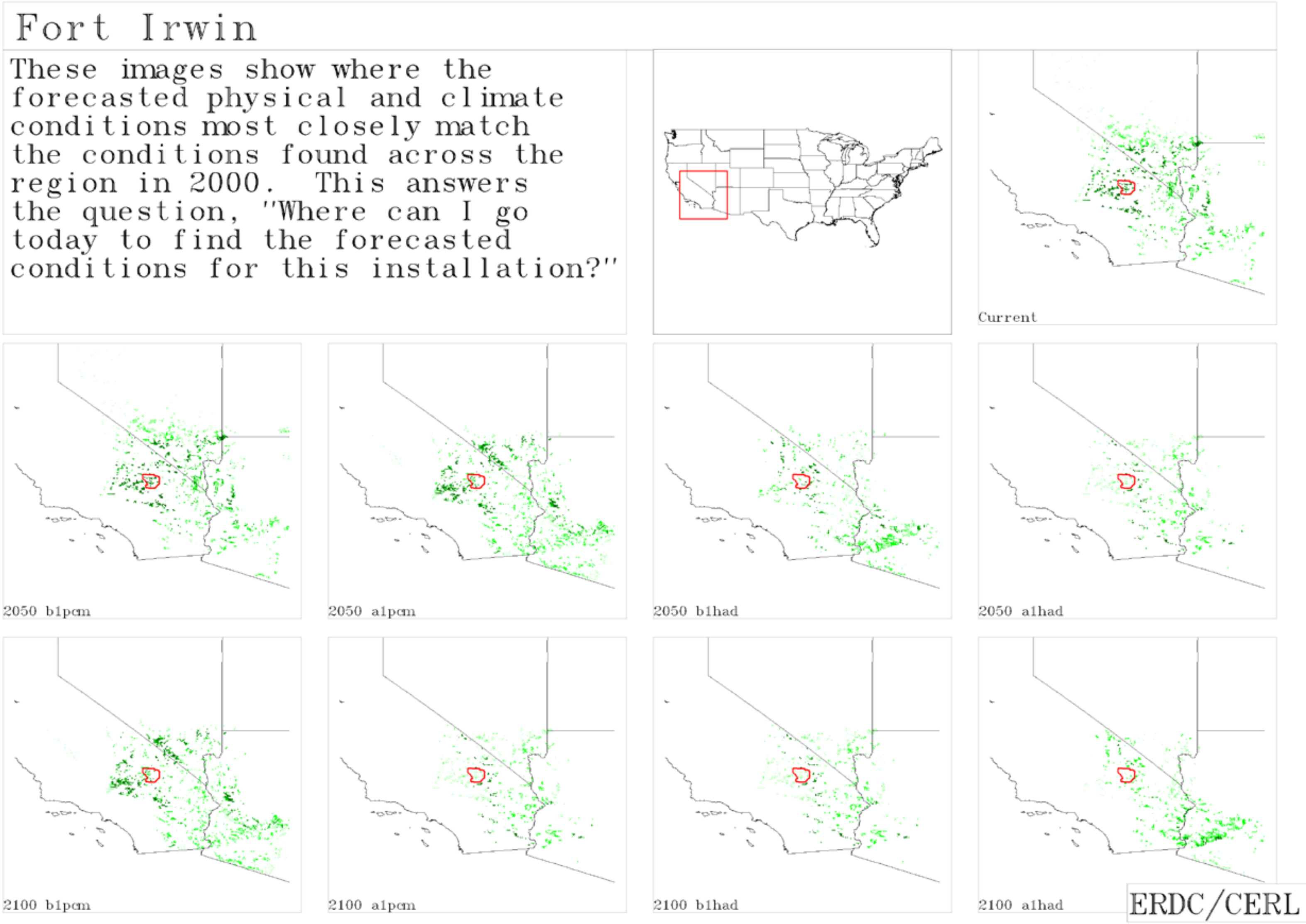

Hunter-Liggett Military Reservation
0) Different from any area in the world in 2000
150) 58% -Nama Karoo
157) 45% -Succulent Karoo
452) 45% -Chilean Matorral
573) 27% -Zagros Mountains Forest Steppe
617) 59% -Middle East Steppe
655) 31% -Aegean And Western Turkey Sclerophyllous And Mixed Forests
666) 55% -Mediterranean Acacia-Argania Dry Woodlands And Succulent Thickets
668) 36% -Mediterranean Woodlands And Forests
673) 85% -Baluchistan Xeric Woodlands
687) 82% -North Saharan Steppe And Woodlands
693) 64% -Registan-North Pakistan Sandy Desert
694) 52% -Sahara Desert
760) 98% -California Central Coast
761) 49% -California South Coast
762) 37% -Great Central Valley
797) 54% -Eyre And York Mallee
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Hunter-Liggett Military Reservation
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

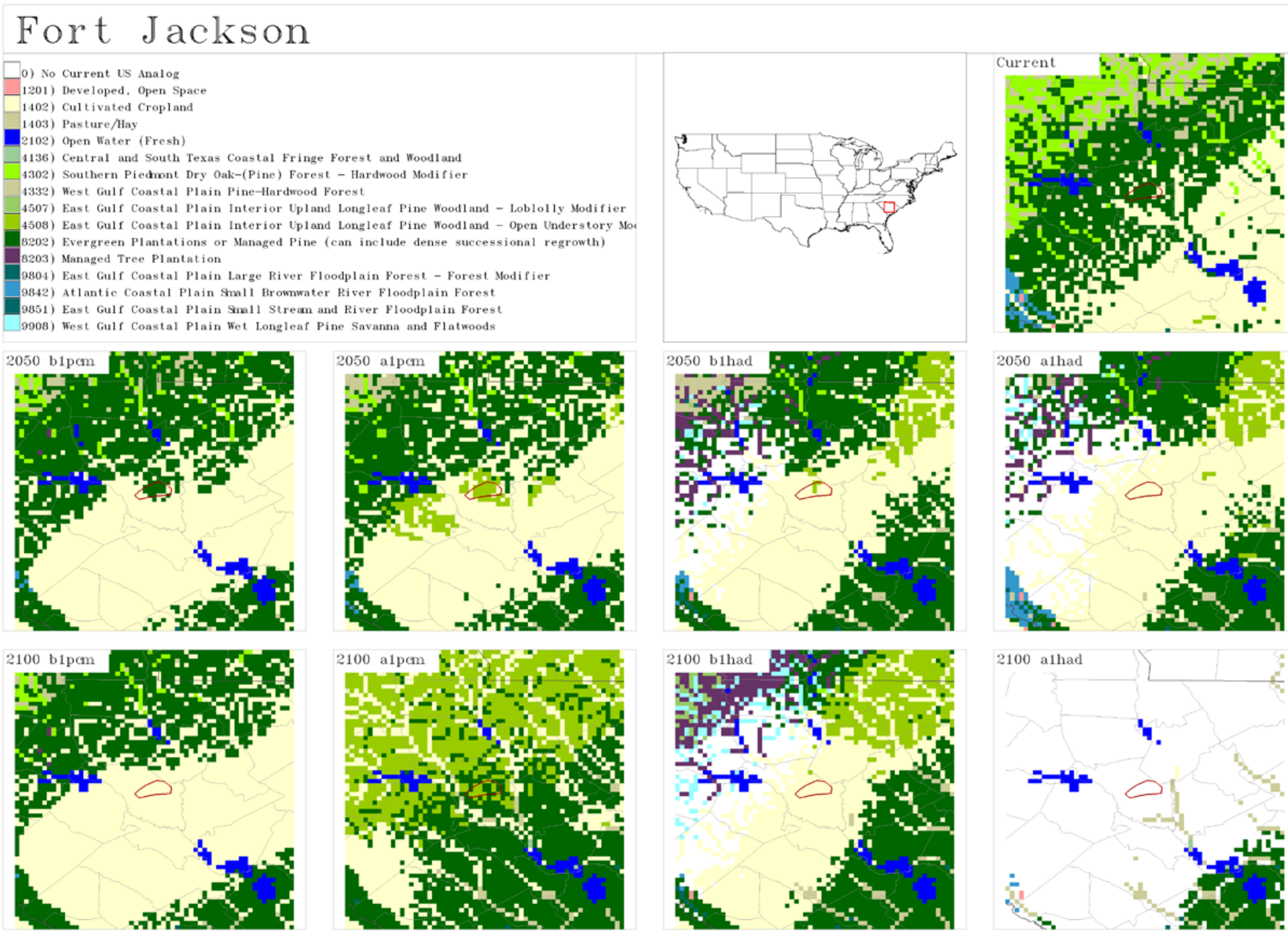
Fort Irwin

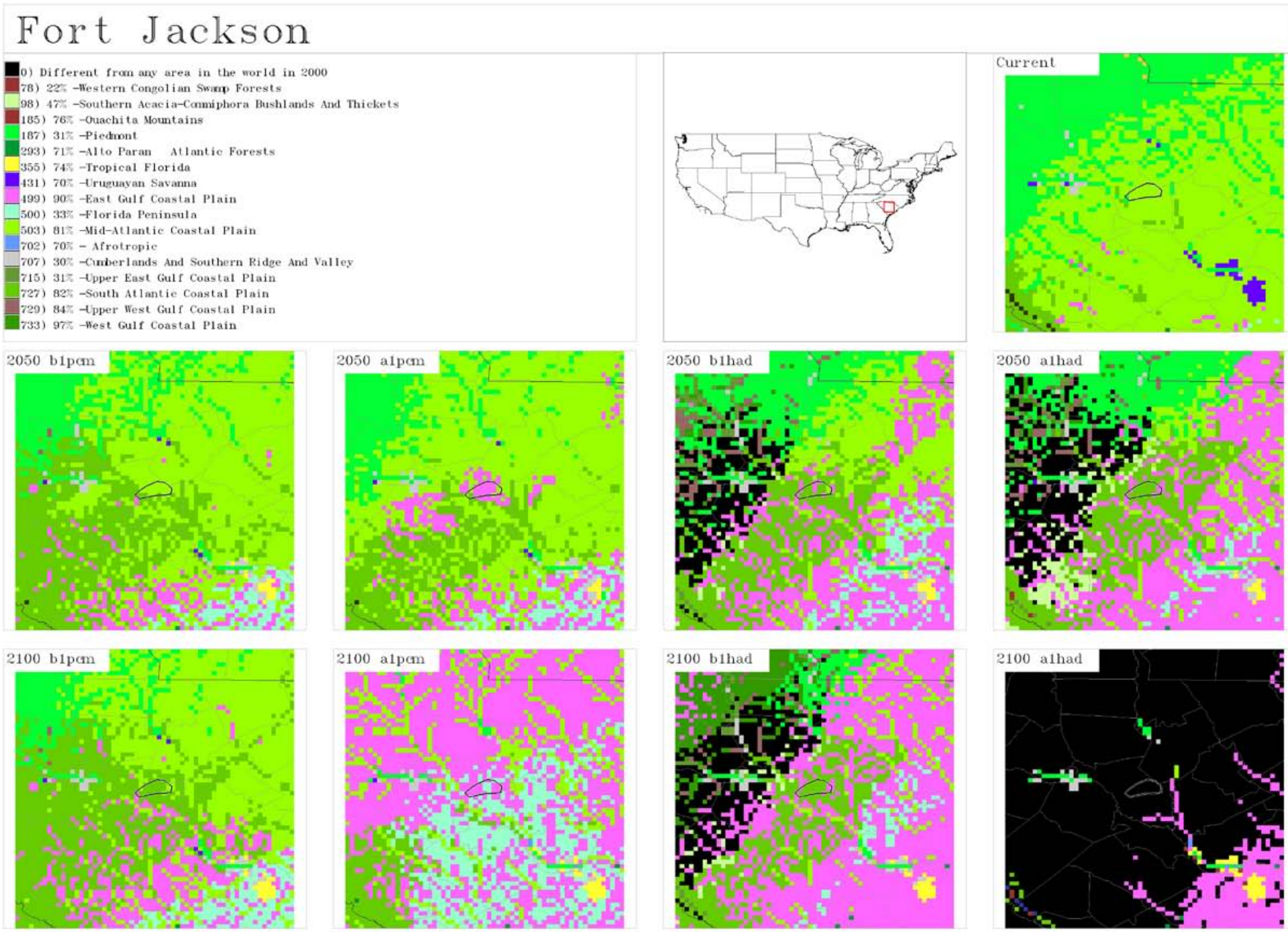

Fort Irwin
5208) Sonora-Mojave Mixed Salt Desert Scrub
5209) Sonoran Mid-Elevation Desert Scrub
5211) Apacherian-Chihuahuan Mesquite Upland Scrub
5212) Chihuahuan Mixed Desert and Thorn Scrub
5213) Sonoran Paloverde-Mixed Cacti Desert Scrub
5303) Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5307) Inter-Mountain Basins Big Sagebrush Steppe
5308) Inter-Mountain Basins Montane Sagebrush Steppe
5309) Inter-Mountain Basins Semi-Desert Shrub Steppe
5407) Mogollon Chaparral
5410) Southern California Dry-Mesic Chaparral
5503) California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna
5603) Inter-Mountain Basins Juniper Savanna
5706) Inter-Mountain Basins Big Sagebrush Shrubland
5803) Colorado Plateau Blackbrush-Mormon-tea Shrubland
7501) California Central Valley and Southern Coastal Grassland
9822) North American Warm Desert Wash
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

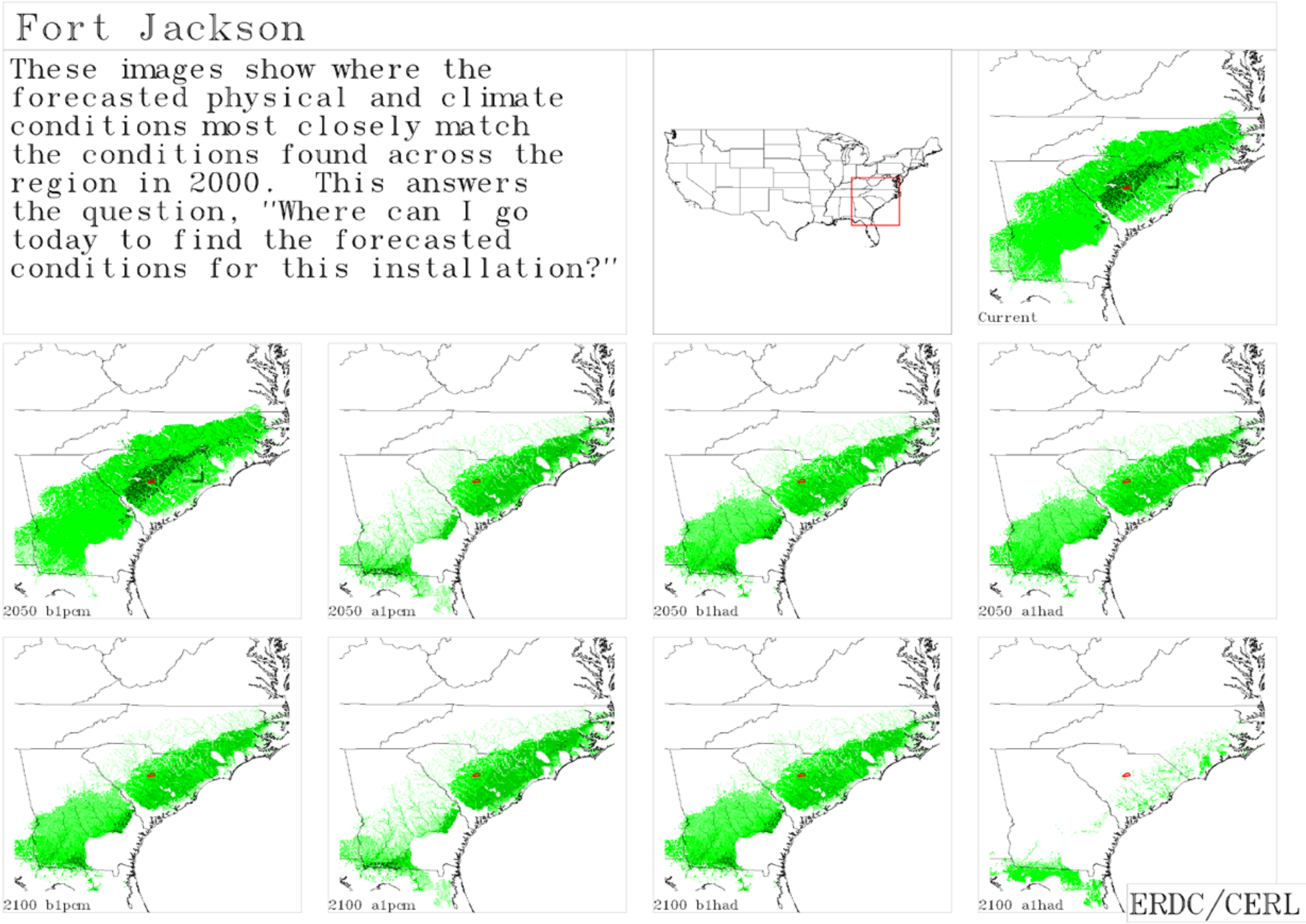

Fort Irwin
0) Different from any area in the world in 2000
259) 57% -Northwestern Thorn Scrub Forests
492) 63% -Arabian Desert And East Sahero-Arabian Xeric Shrublands
573) 27% -Zagros Mountains Forest Steppe
580) 15% -Elburz Range Forest Steppe
667) 78% -Mediterranean Dry Woodlands And Steppe
673) 85% -Baluchistan Xeric Woodlands
679) 52% -Central Persian Desert Basins
687) 82% -North Saharan Steppe And Woodlands
693) 64% -Registan-North Pakistan Sandy Desert
694) 52% -Sahara Desert
695) 100% -South Iran Nubo-Sindian Desert And Semi-Desert
760) 98% -California Central Coast
766) 59% -Colorado Plateau
768) 73% -Great Basin
769) 17% -Mojave Desert
770) 45% -Sonoran Desert
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



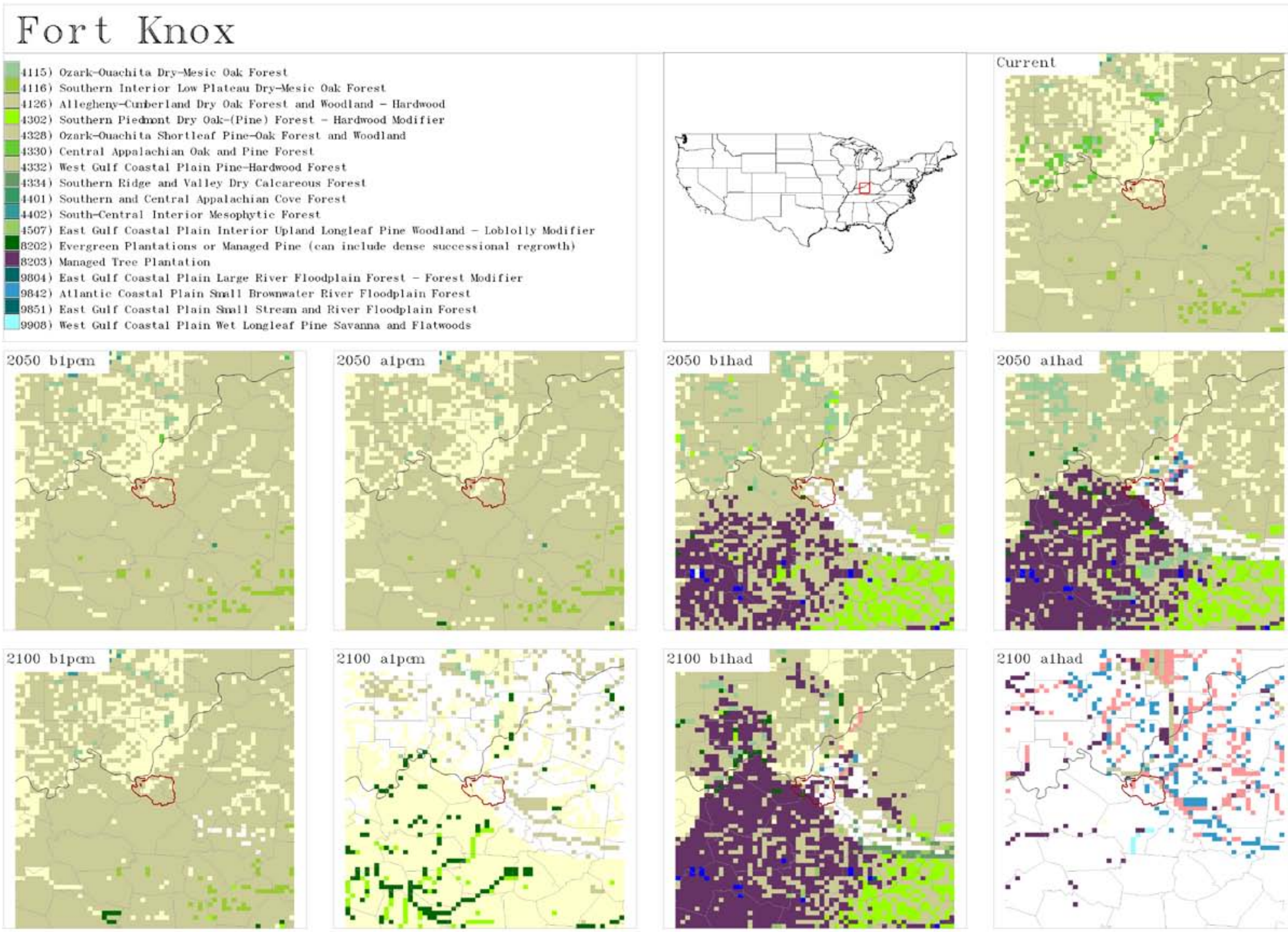
Fort Jackson

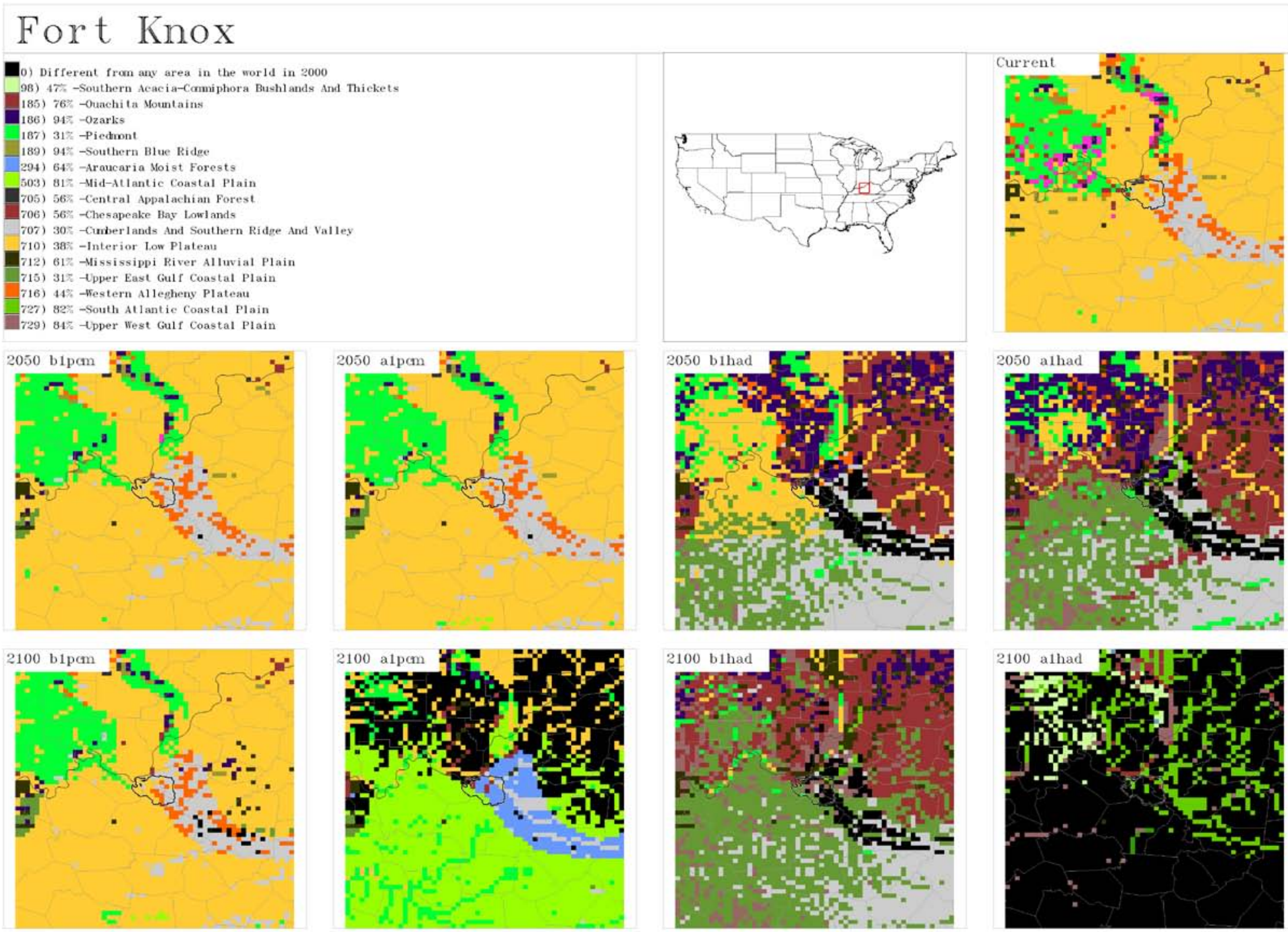

Fort Jackson
0) No Current US Analog
1201) Developed, Open Space
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
4136) Central and South Texas Coastal Fringe Forest and Woodland
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier
4332) West Gulf Coastal Plain Pine-Hardwood Forest
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Loblolly Modifier
4508) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Open Understory Mo
8202) Evergreen Plantations or Managed Pine (can include dense successional regrowth)
8203) Managed Tree Plantation
9804) East Gulf Coastal Plain Large River Floodplain Forest - Forest Modifier
9842) Atlantic Coastal Plain Small Brownwater River Floodplain Forest
9851) East Gulf Coastal Plain Small Stream and River Floodplain Forest
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

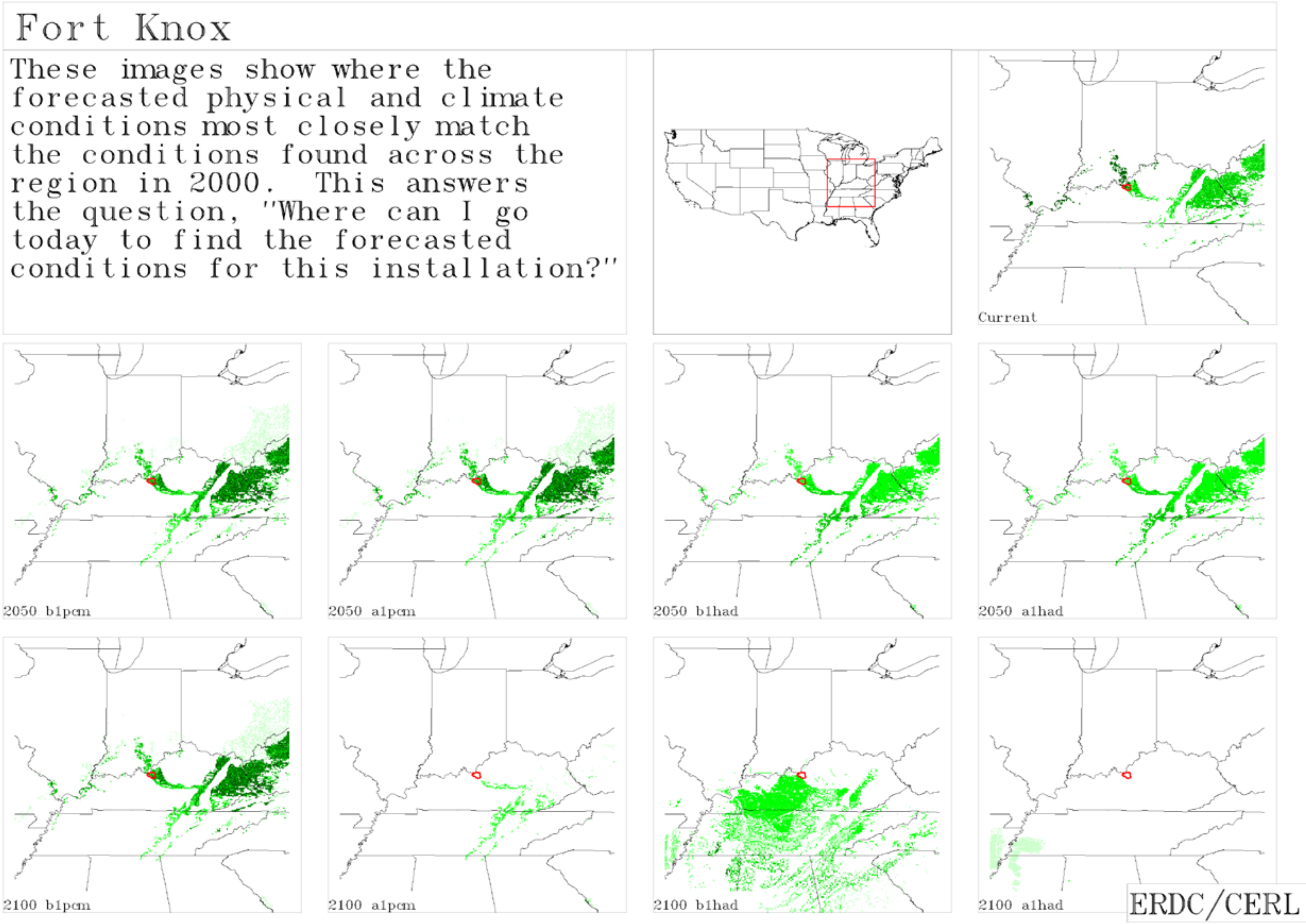

Fort Jackson
0) Different from any area in the world in 2000
78) 22% -Western Congolian Swamp Forests
98) 47% -Southern Acacia-Commiphora Bushlands And Thickets
185) 76% -Ouachita Mountains
187) 31% -Piedmont
293) 71% -Alto Paran   Atlantic Forests
355) 74% -Tropical Florida
431) 70% -Uruguayan Savanna
499) 90% -East Gulf Coastal Plain
500) 33% -Florida Peninsula
503) 81% -Mid-Atlantic Coastal Plain
702) 70% - Afrotropic
707) 30% -Cumberlands And Southern Ridge And Valley
715) 31% -Upper East Gulf Coastal Plain
727) 82% -South Atlantic Coastal Plain
729) 84% -Upper West Gulf Coastal Plain
733) 97% -West Gulf Coastal Plain
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Fort Jackson
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

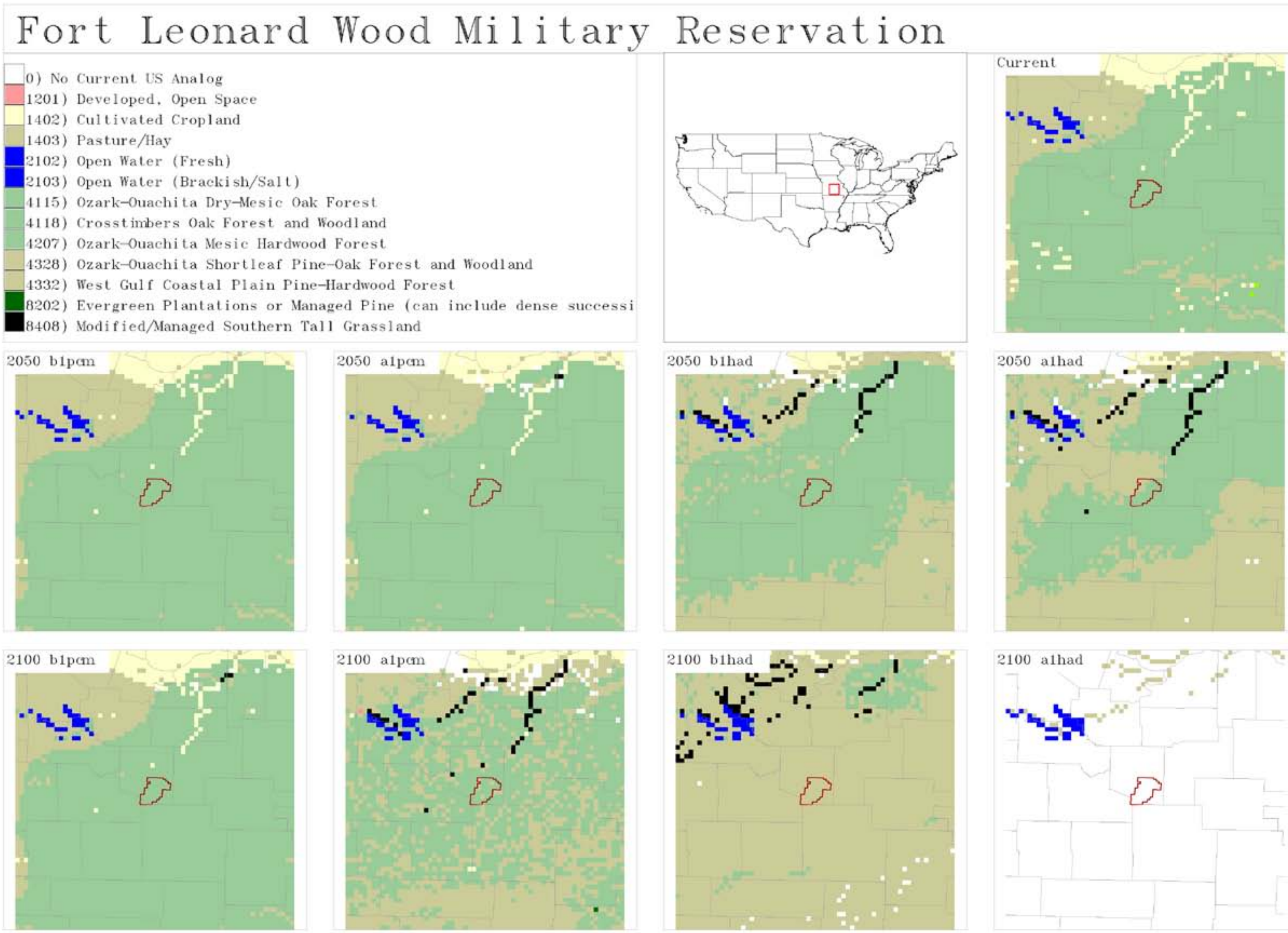
Fort Knox

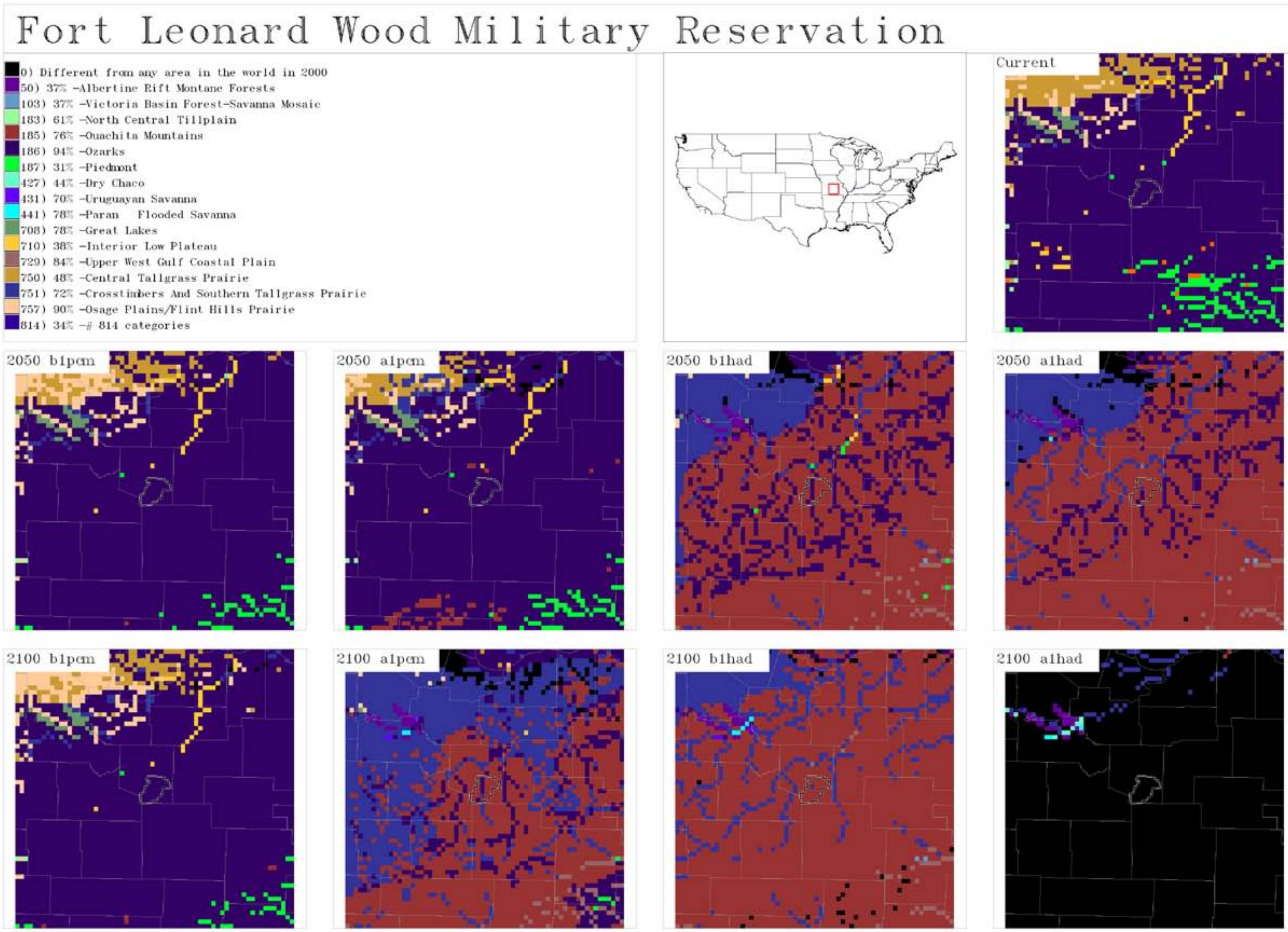

Fort Knox
4115) Ozark-Ouachita Dry-Mesic Oak Forest
4116) Southern Interior Low Plateau Dry-Mesic Oak Forest
4126) Allegheny-Cumberland Dry Oak Forest and Woodland - Hardwood
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier
4328) Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland
4330) Central Appalachian Oak and Pine Forest
4332) West Gulf Coastal Plain Pine-Hardwood Forest
4334) Southern Ridge and Valley Dry Calcareous Forest
4401) Southern and Central Appalachian Cove Forest
4402) South-Central Interior Mesophytic Forest
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Loblolly Modifier
8202) Evergreen Plantations or Managed Pine (can include dense successional regrowth)
8203) Managed Tree Plantation
9804) East Gulf Coastal Plain Large River Floodplain Forest - Forest Modifier
9842) Atlantic Coastal Plain Small Brownwater River Floodplain Forest
9851) East Gulf Coastal Plain Small Stream and River Floodplain Forest
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

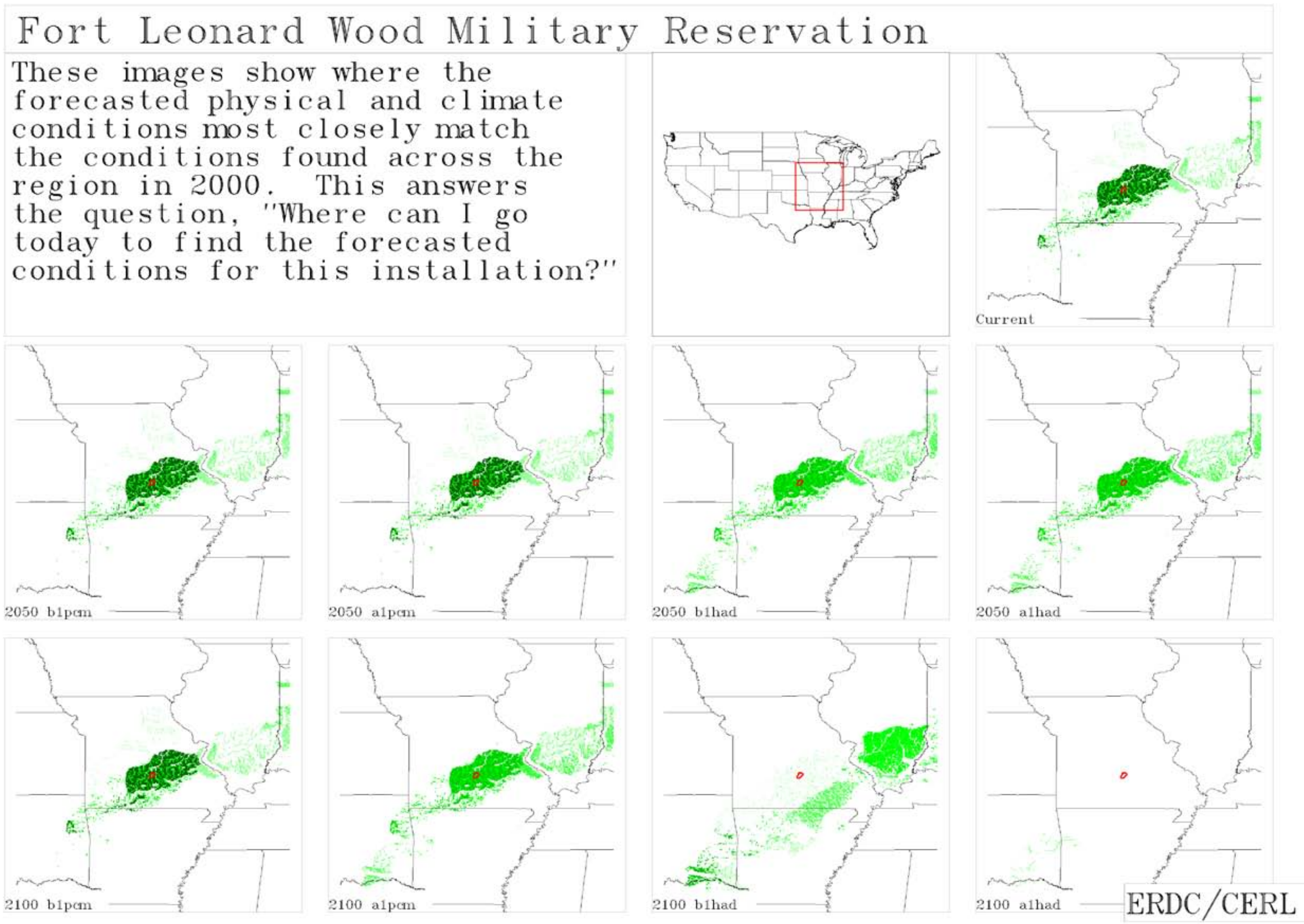

Fort Knox
0) Different from any area in the world in 2000
98) 47% -Southern Acacia-Commiphora Bushlands And Thickets
185) 76% -Ouachita Mountains
186) 94% -Ozarks
187) 31% -Piedmont
189) 94% -Southern Blue Ridge
294) 64% -Araucaria Moist Forests
503) 81% -Mid-Atlantic Coastal Plain
705) 56% -Central Appalachian Forest
706) 56% -Chesapeake Bay Lowlands
707) 30% -Cumberlands And Southern Ridge And Valley
710) 38% -Interior Low Plateau
712) 61% -Mississippi River Alluvial Plain
715) 31% -Upper East Gulf Coastal Plain
716) 44% -Western Allegheny Plateau
727) 82% -South Atlantic Coastal Plain
729) 84% -Upper West Gulf Coastal Plain
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



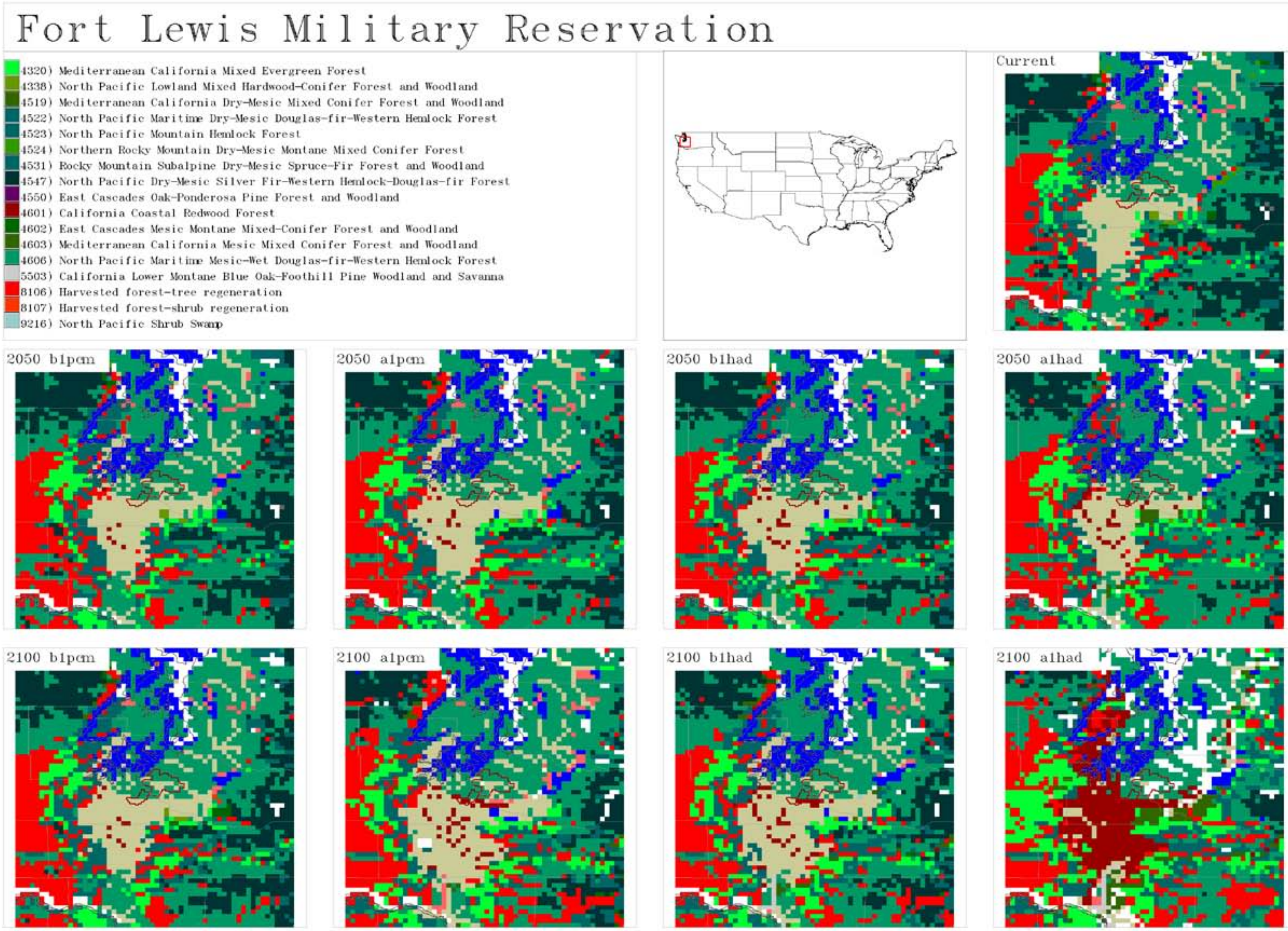
Fort Leonard Wood Military Reservation


Fort Leonard Wood Military Reservation
0) No Current US Analog
1201) Developed, Open Space
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
2103) Open Water (Brackish/Salt)
4115) Ozark-Ouachita Dry-Mesic Oak Forest
4118) Crosstimbers Oak Forest and Woodland
4207) Ozark-Ouachita Mesic Hardwood Forest
4328) Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland
4332) West Gulf Coastal Plain Pine-Hardwood Forest
8202) Evergreen Plantations or Managed Pine (can include dense successi
8408) Modified/Managed Southern Tall Grassland
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

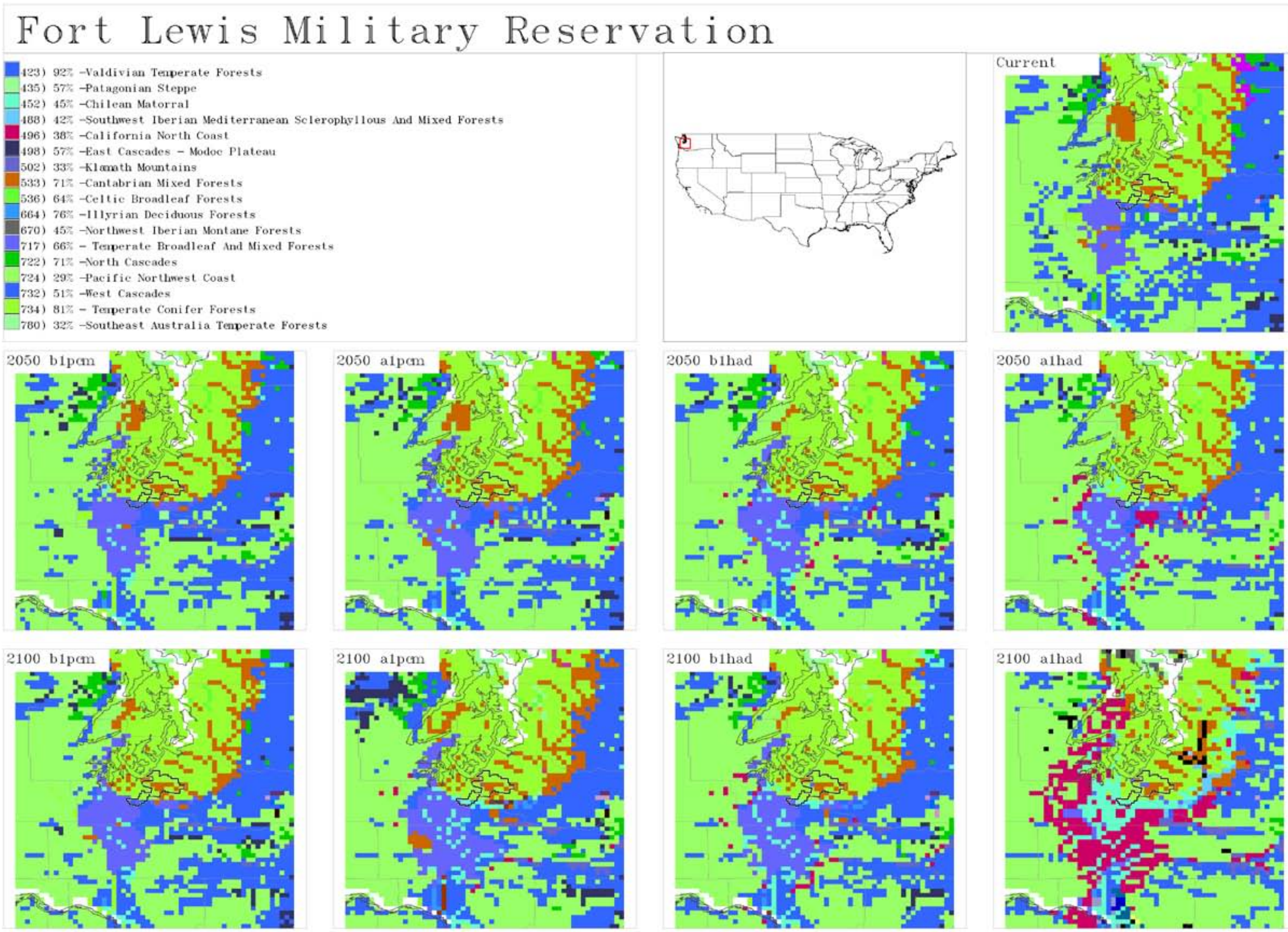

Fort Leonard Wood Military Reservation
0) Different from any area in the world in 2000
50) 37% -Albertine Rift Montane Forests
103) 37% -Victoria Basin Forest-Savanna Mosaic
183) 61% -North Central Tillplain
185) 76% -Ouachita Mountains
186) 94% -Ozarks
187) 31% -Piedmont
427) 44% -Dry Chaco
431) 70% -Uruguayan Savanna
441) 78% -Paran Flooded Savanna
708) 78% -Great Lakes
710) 38% -Interior Low Plateau
729) 84% -Upper West Gulf Coastal Plain
750) 48% -Central Tallgrass Prairie
751) 72% -Crosstimbers And Southern Tallgrass Prairie
757) 90% -Osage Plains/Flint Hills Prairie
814) 34% -# 814 categories
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

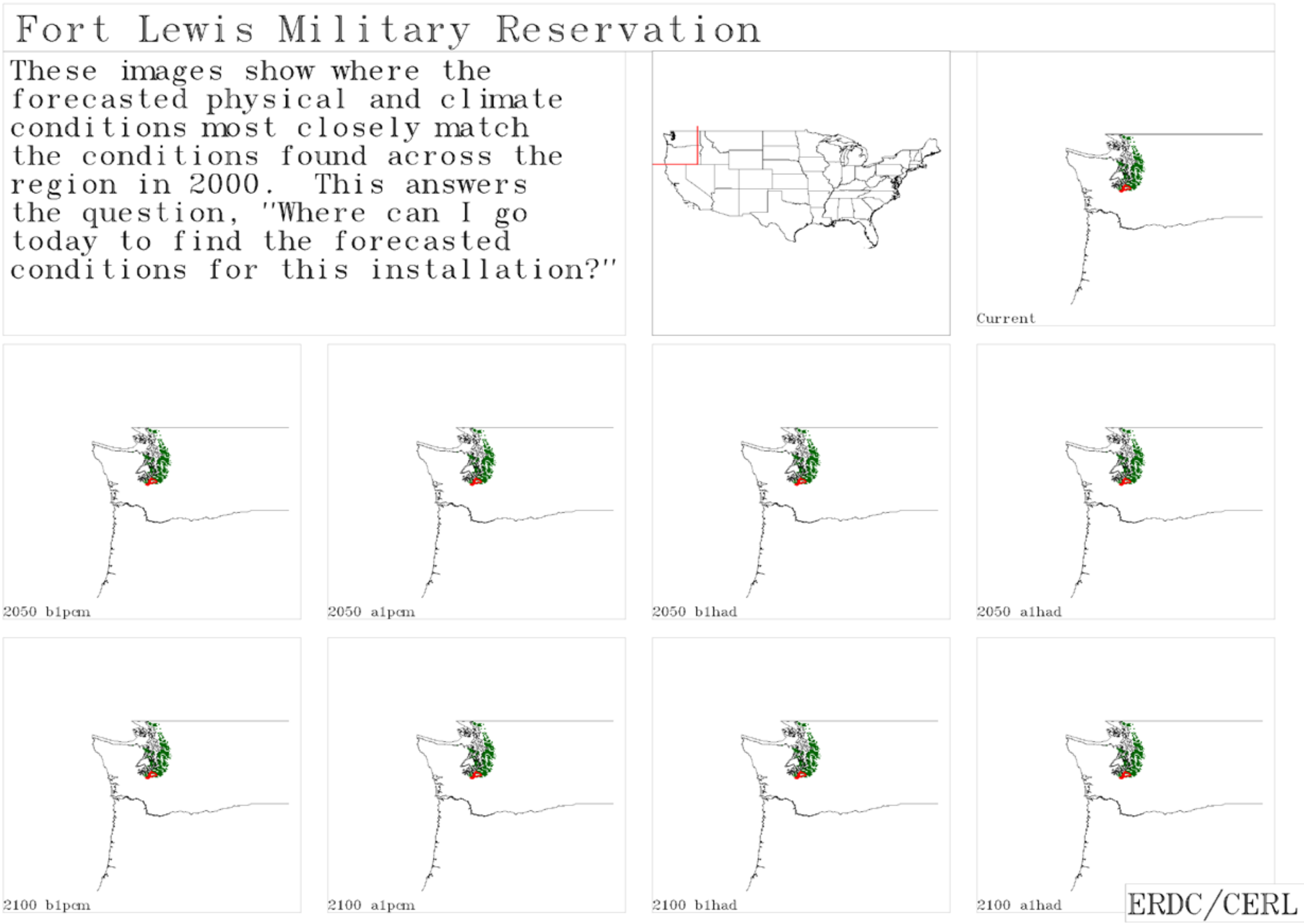


Fort Lewis Wood Military Reservation

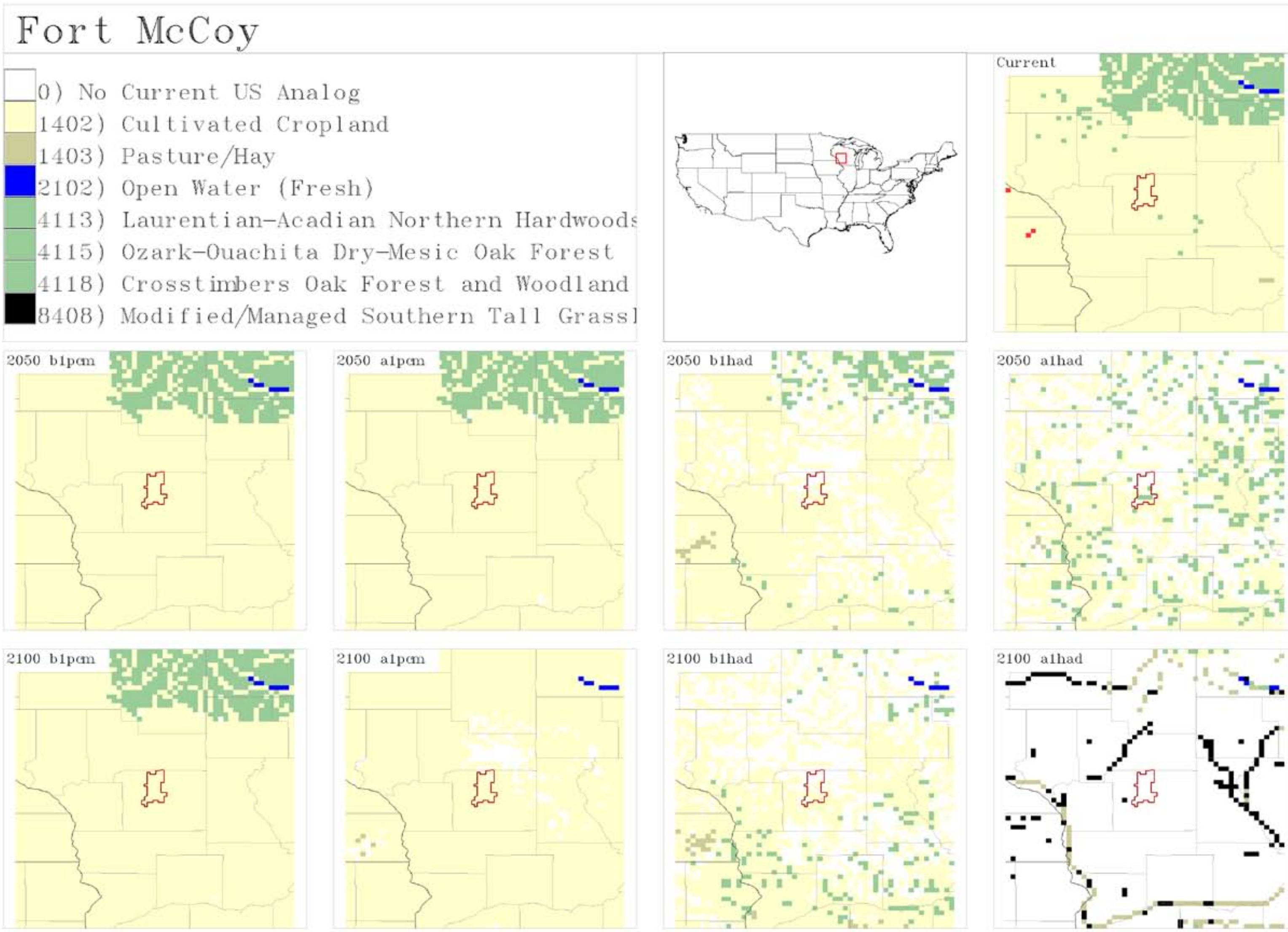


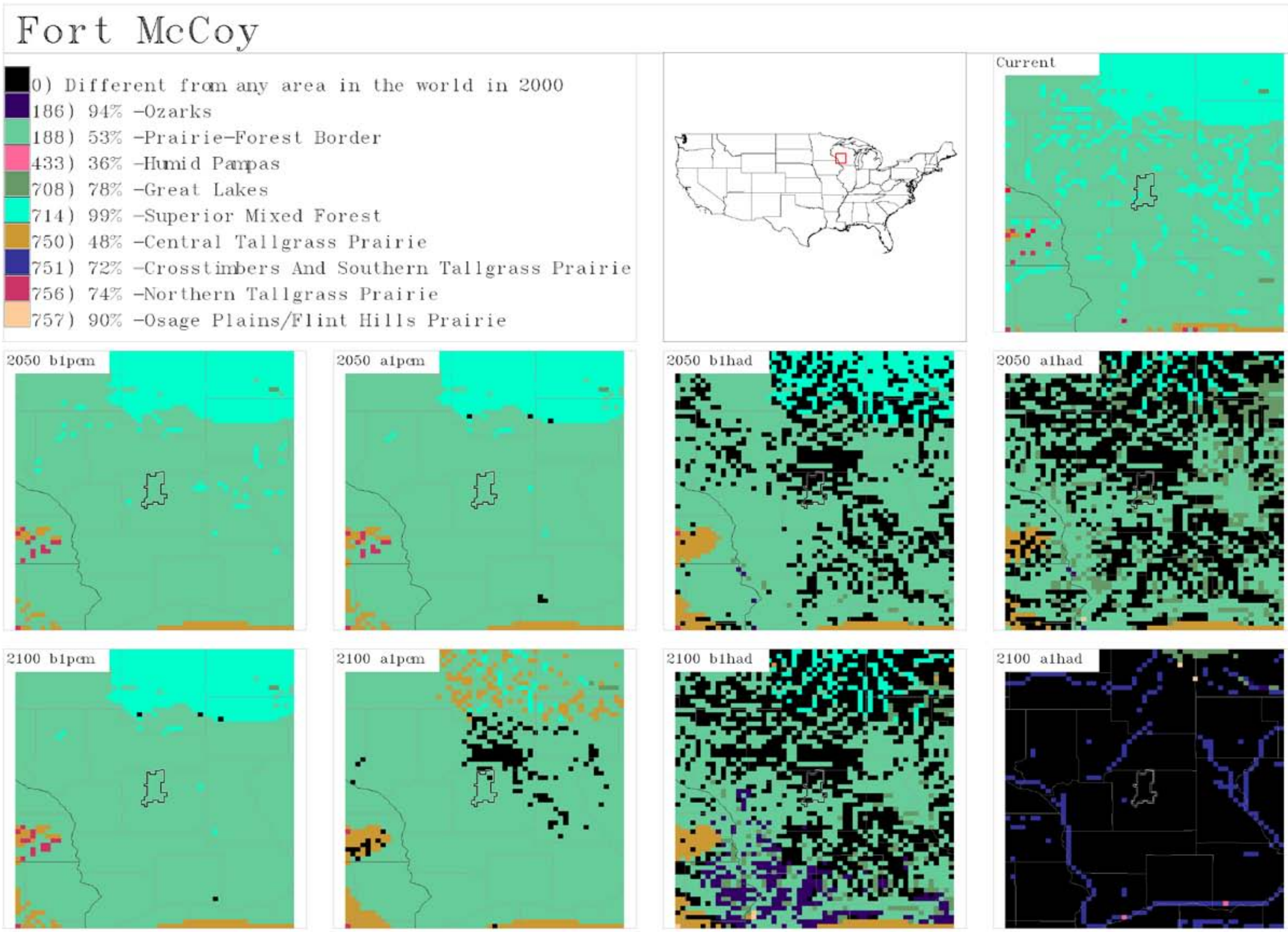
Fort Lewis Military Reservation
4320) Mediterranean California Mixed Evergreen Forest
4338) North Pacific Lowland Mixed Hardwood-Conifer Forest and Woodland
4519) Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
4522) North Pacific Maritime Dry-Mesic Douglas-fir-Western Hemlock Forest
4523) North Pacific Mountain Hemlock Forest
4524) Northern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest
4531) Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland
4547) North Pacific Dry-Mesic Silver Fir-Western Hemlock-Douglas-fir Forest
4550) East Cascades Oak-Ponderosa Pine Forest and Woodland
4601) California Coastal Redwood Forest
4602) East Cascades Mesic Montane Mixed-Conifer Forest and Woodland
4603) Mediterranean California Mesic Mixed Conifer Forest and Woodland
4606) North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock Forest
5503) California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna
8106) Harvested forest-tree regeneration
8107) Harvested forest-shrub regeneration
9216) North Pacific Shrub Swamp
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

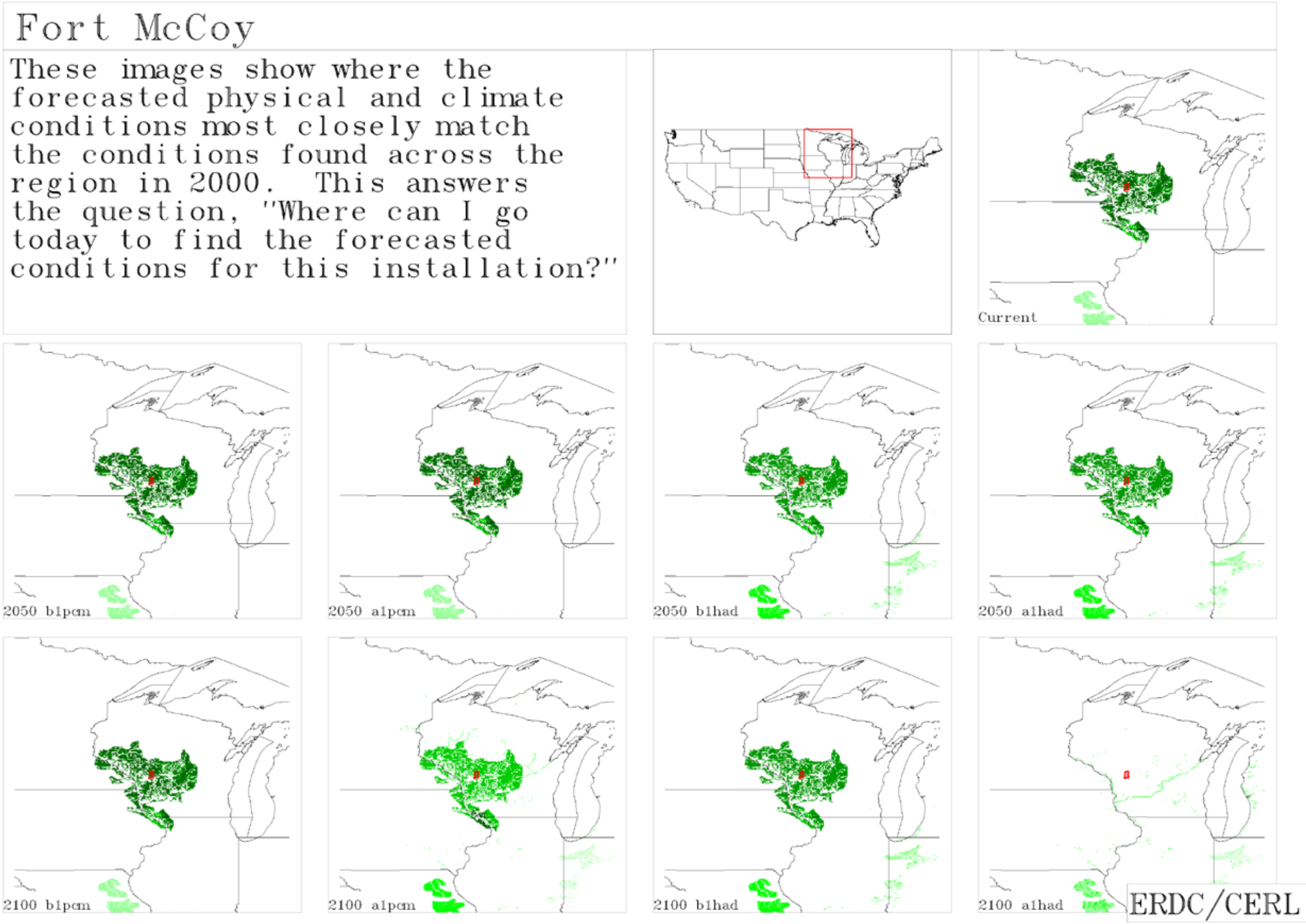

Fort Lewis Military Reservation
423) 92% -Valdivian Temperate Forests
435) 57% -Patagonian Steppe
452) 45% -Chilean Matorral
488) 42% -Southwest Iberian Mediterranean Sclerophyllous And Mixed Forests
496) 38% -California North Coast
498) 57% -East Cascades - Modoc Plateau
502) 33% -Klamath Mountains
533) 71% -Cantabrian Mixed Forests
536) 64% -Celtic Broadleaf Forests
664) 76% -Illyrian Deciduous Forests
670) 45% -Northwest Iberian Montane Forests
717) 66% - Temperate Broadleaf And Mixed Forests
722) 71% -North Cascades
724) 29% -Pacific Northwest Coast
732) 51% -West Cascades
734) 81% - Temperate Conifer Forests
780) 32% -Southeast Australia Temperate Forests
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Fort Lewis Military Reservation
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

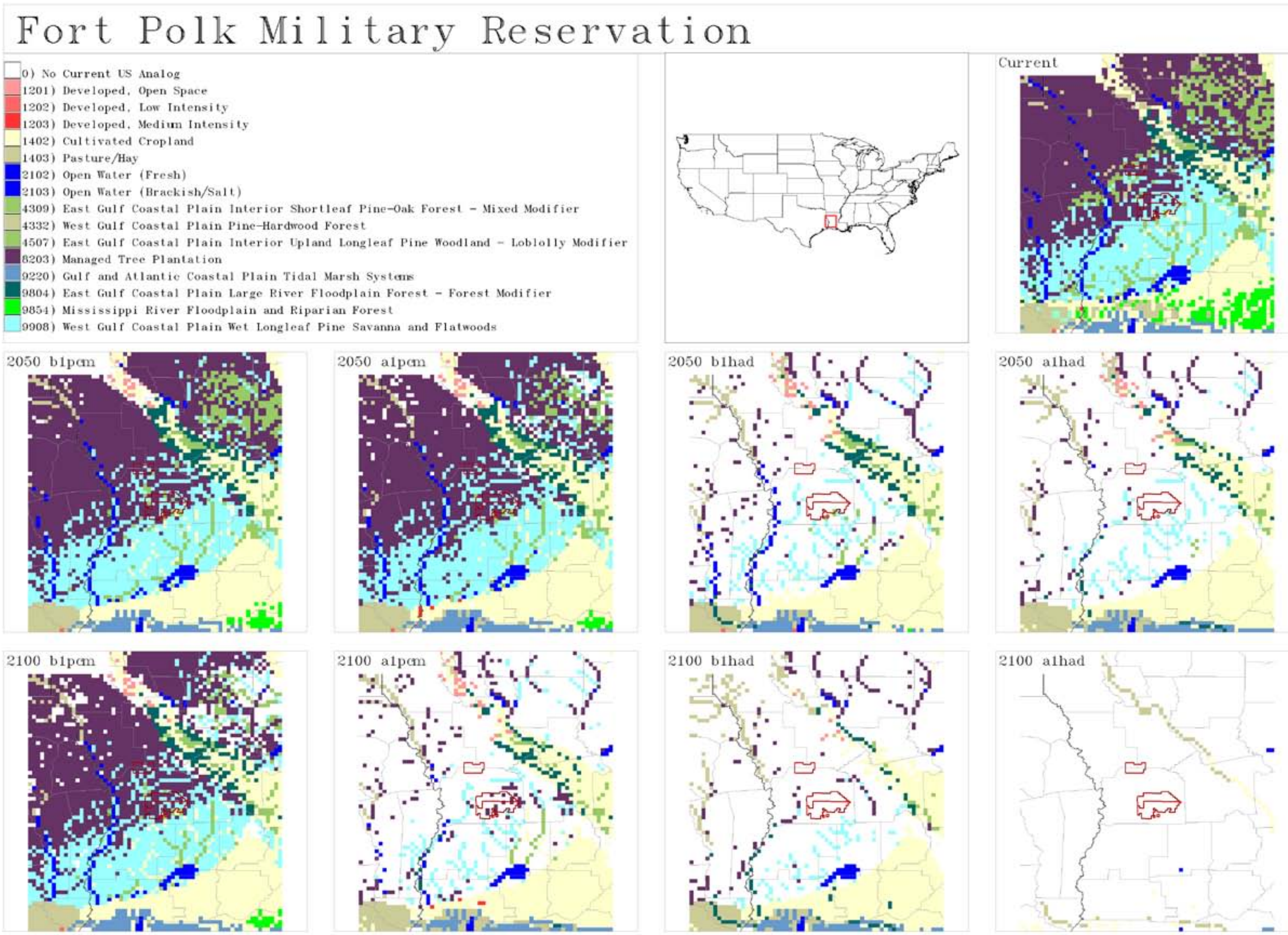
Fort McCoy

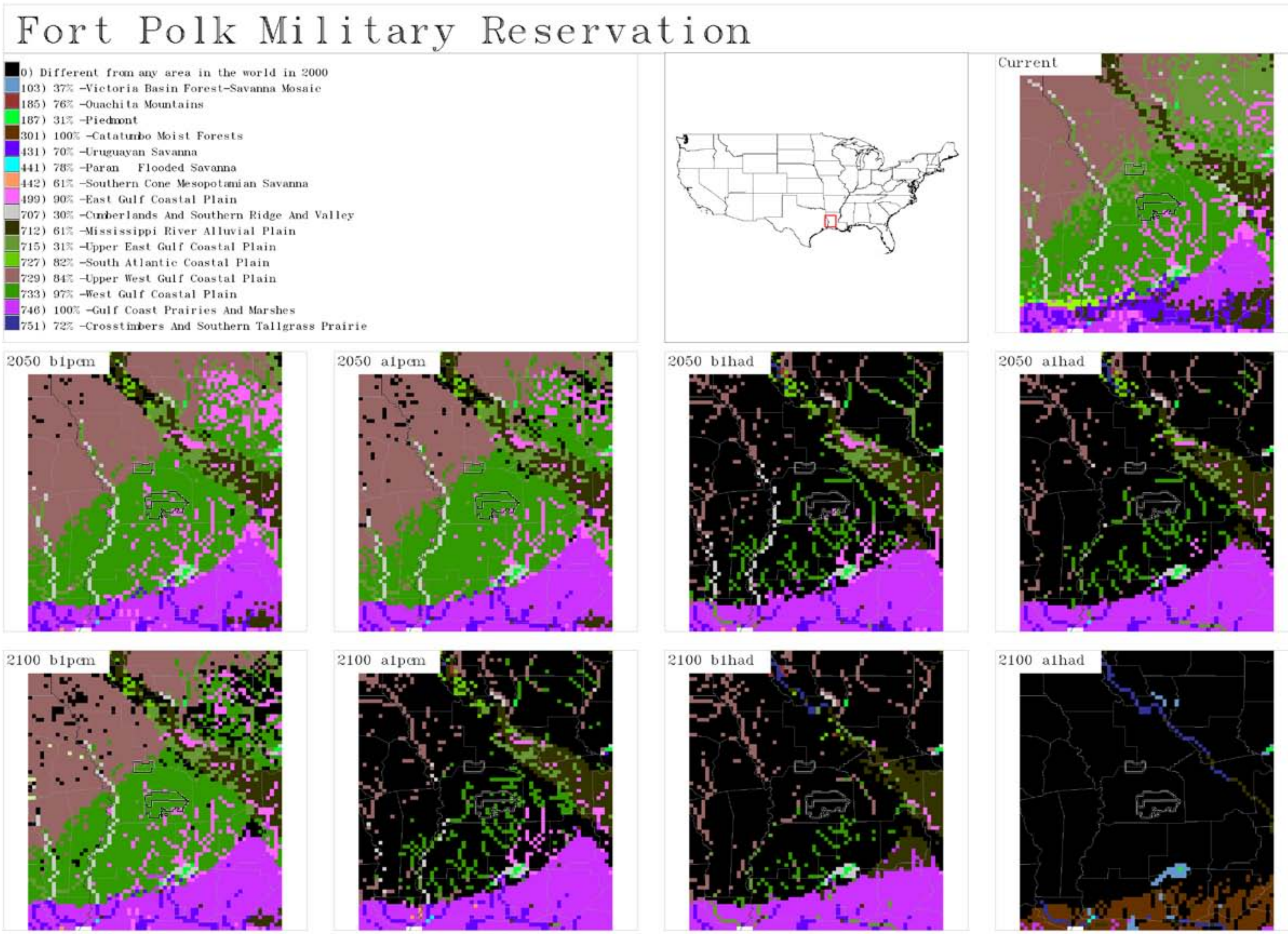

Fort McCoy
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
4113) Laurentian-Acadian Northern Hardwoods
4115) Ozark-Ouachita Dry-Mesic Oak Forest
4118) Crosstimbers Oak Forest and Woodland
8408) Modified/Managed Southern Tall Grassl
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

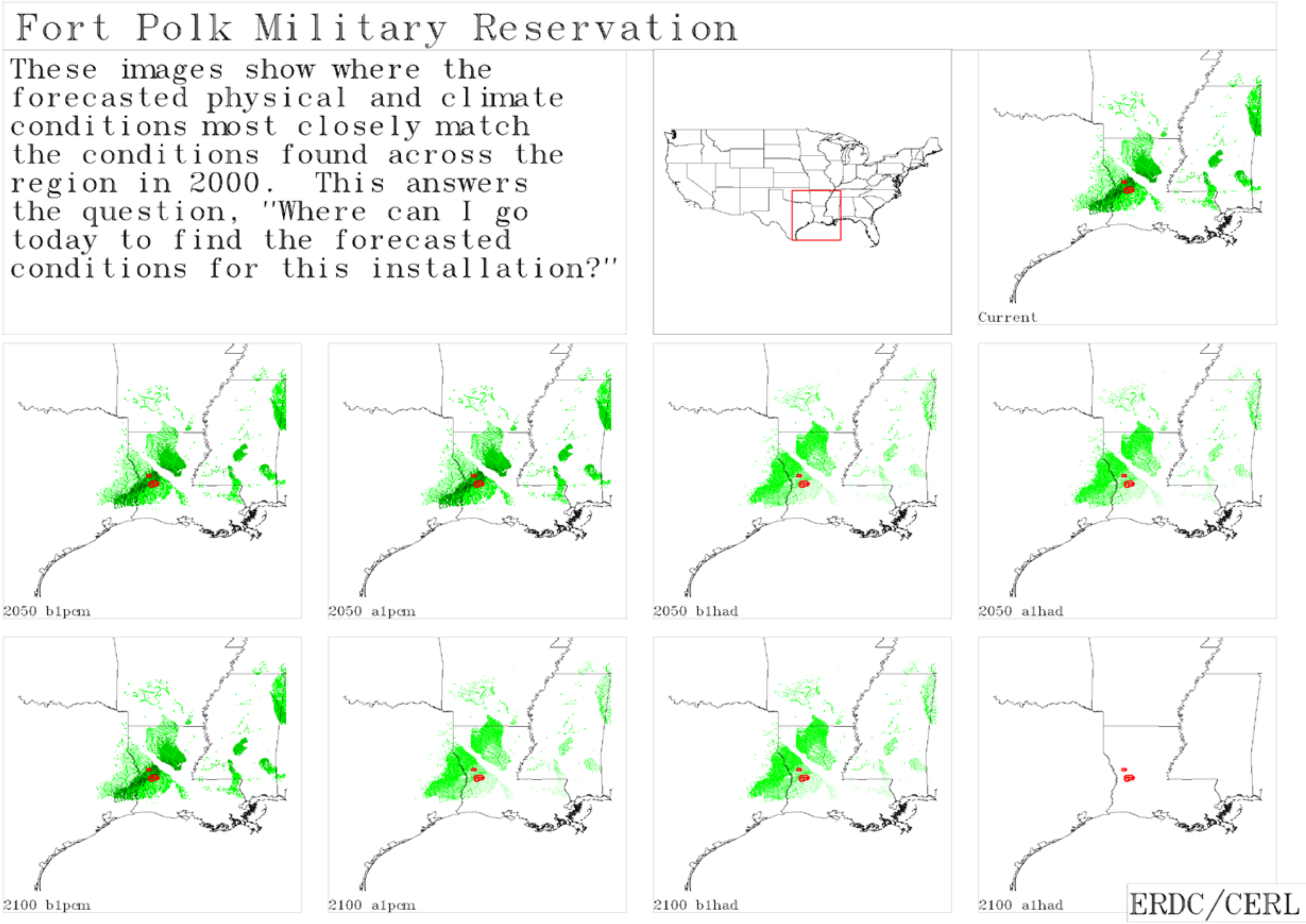

Fort McCoy
0) Different from any area in the world in 2000
186) 94% -Ozarks
188) 53% -Prairie-Forest Border
433) 36% -Humid Pampas
708) 78% -Great Lakes
714) 99% -Superior Mixed Forest
750) 48% -Central Tallgrass Prairie
751) 72% -Crosstimbers And Southern Tallgrass Prairie
756) 74% -Northern Tallgrass Prairie
757) 90% -Osage Plains/Flint Hills Prairie
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



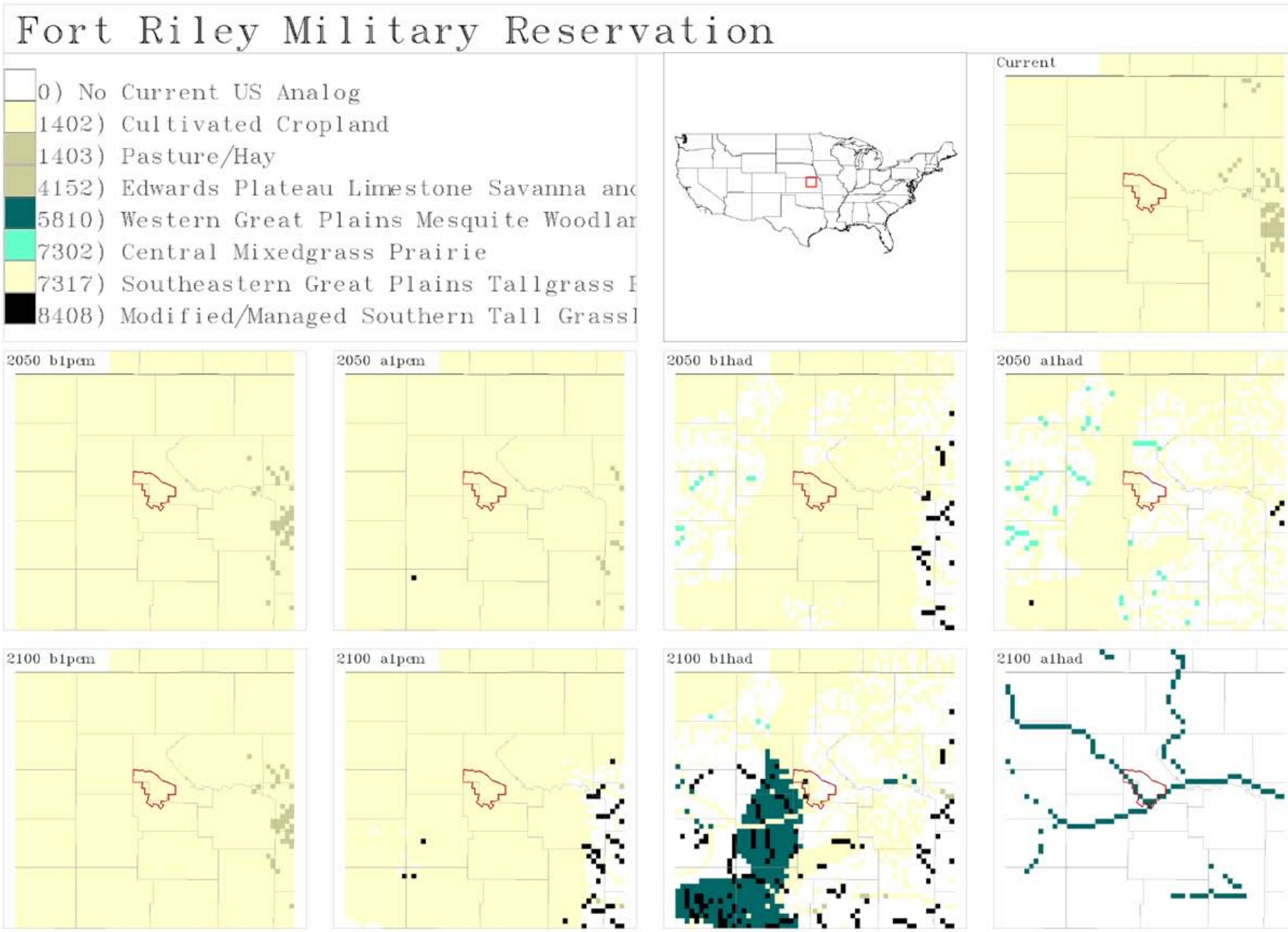
Fort Polk Military Reservation

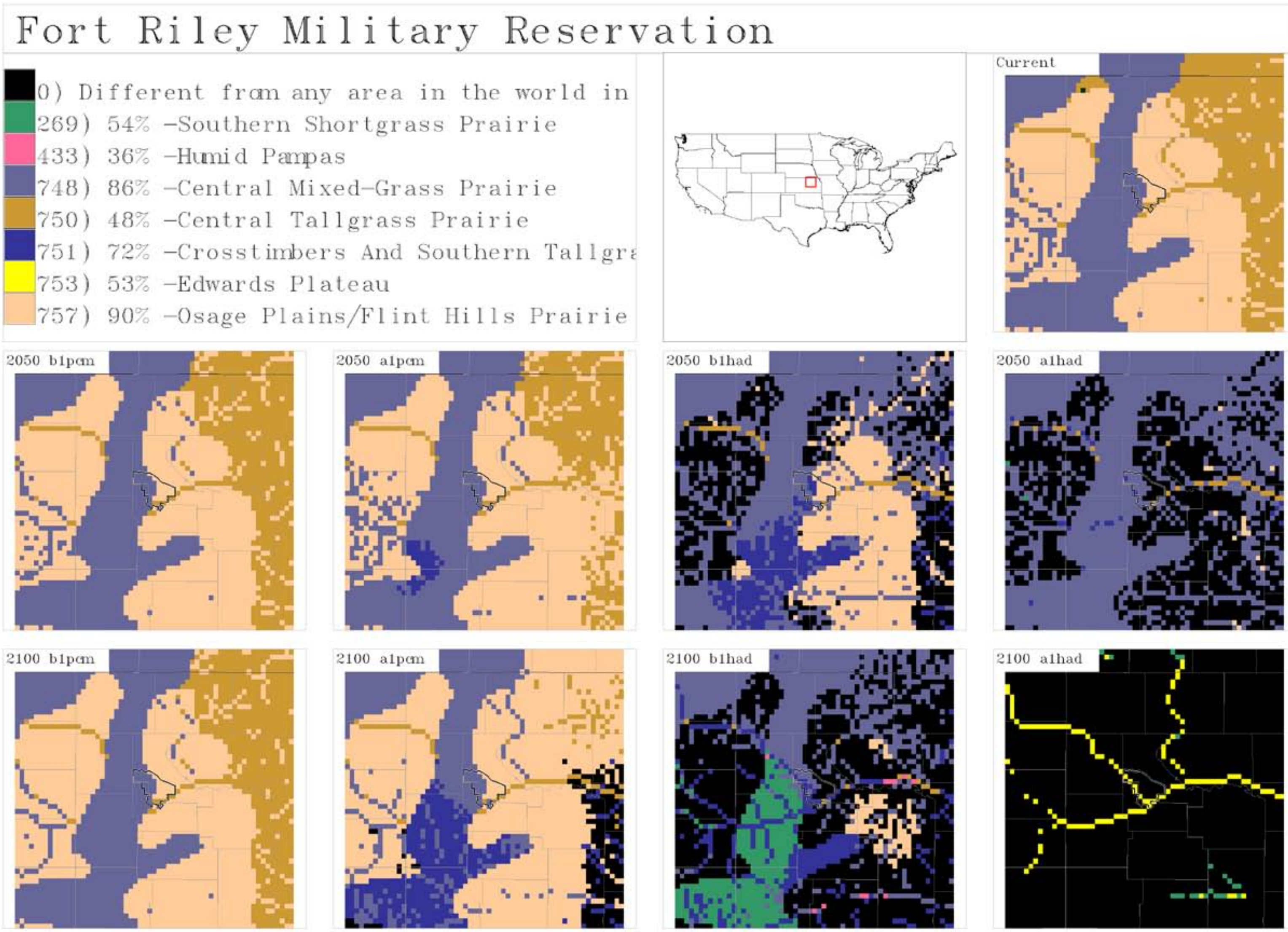

Fort Polk Military Reservation
0) No Current US Analog
1201) Developed, Open Space
1202) Developed, Low Intensity
1203) Developed, Medium Intensity
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
2103) Open Water (Brackish/Salt)
4309) East Gulf Coastal Plain Interior Shortleaf Pine-Oak Forest - Mixed Modifier
4332) West Gulf Coastal Plain Pine-Hardwood Forest
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine Woodland - Loblolly Modifier
8203) Managed Tree Plantation
9220) Gulf and Atlantic Coastal Plain Tidal Marsh Systems
9804) East Gulf Coastal Plain Large River Floodplain Forest - Forest Modifier
9854) Mississippi River Floodplain and Riparian Forest
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

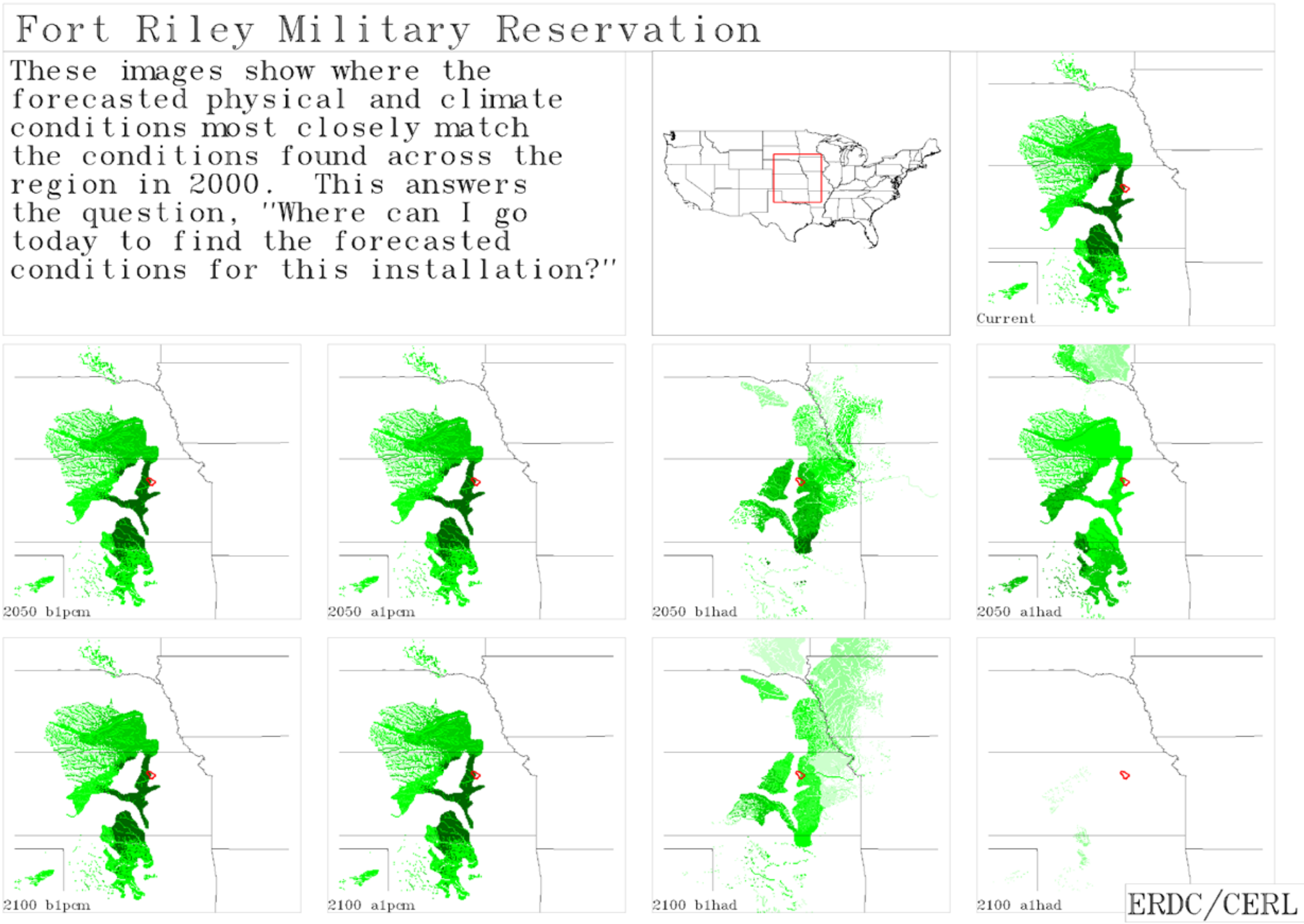

Fort Polk Military Reservation
0) Different from any area in the world in 2000
103) 37% -Victoria Basin Forest-Savanna Mosaic
185) 76% -Ouachita Mountains
187) 31% -Piedmont
301) 100% -Catatumbo Moist Forests
431) 70% -Uruguayan Savanna
441) 78% -Paran Flooded Savanna
442) 61% -Southern Cone Mesopotamian Savanna
499) 90% -East Gulf Coastal Plain
707) 30% -Cumberlands And Southern Ridge And Valley
712) 61% -Mississippi River Alluvial Plain
715) 31% -Upper East Gulf Coastal Plain
727) 82% -South Atlantic Coastal Plain
729) 84% -Upper West Gulf Coastal Plain
733) 97% -West Gulf Coastal Plain
746) 100% -Gulf Coast Prairies And Marshes
751) 72% -Crosstimbers And Southern Tallgrass Prairie
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



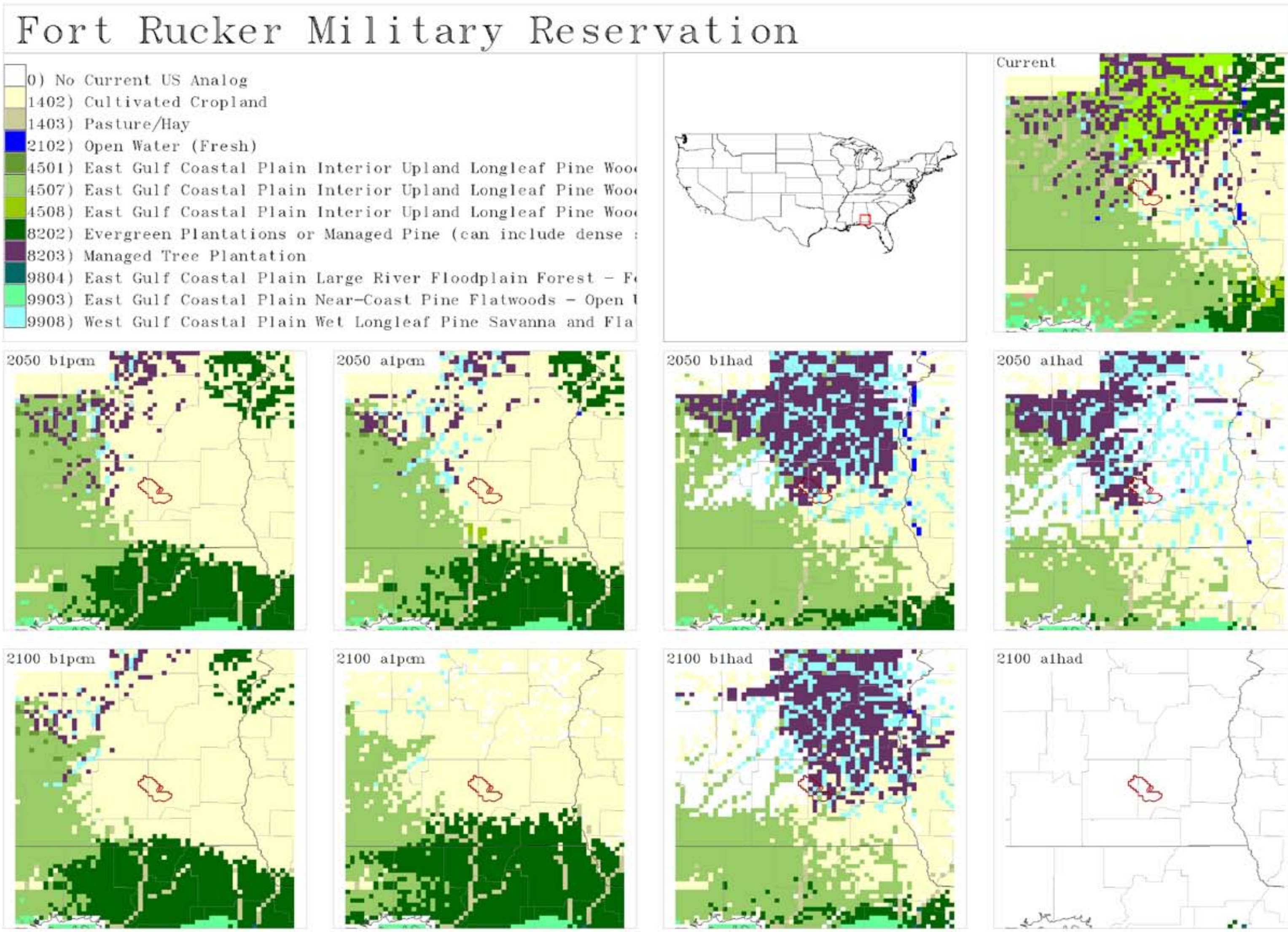
Fort Riley Military Reservation

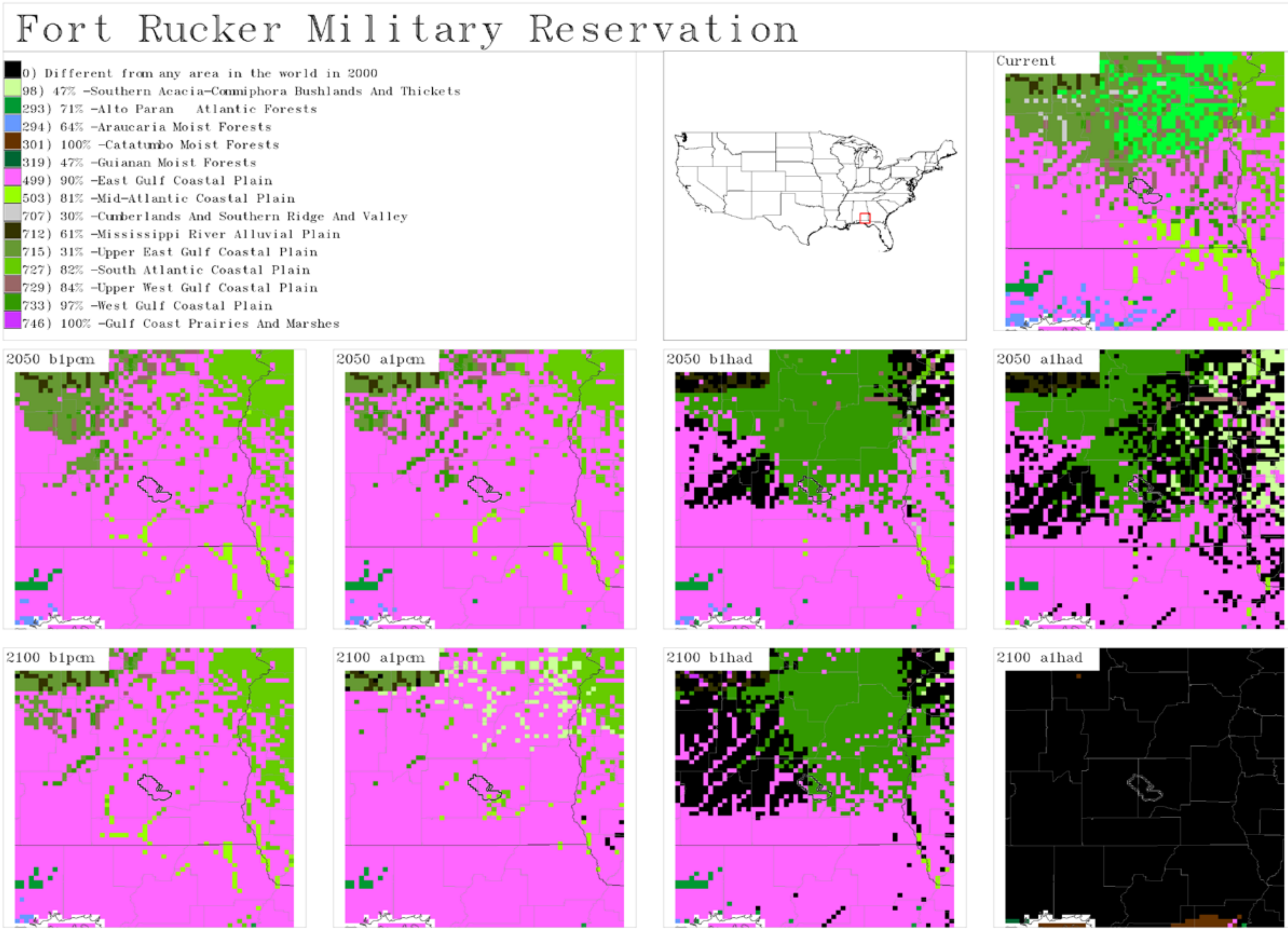

Fort Riley Military Reservation
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
4152) Edwards Plateau Limestone Savanna and
5810) Western Great Plains Mesquite Woodlan
7302) Central Mixedgrass Prairie
7317) Southeastern Great Plains Tallgrass P
8408) Modified/Managed Southern Tall Grassl
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

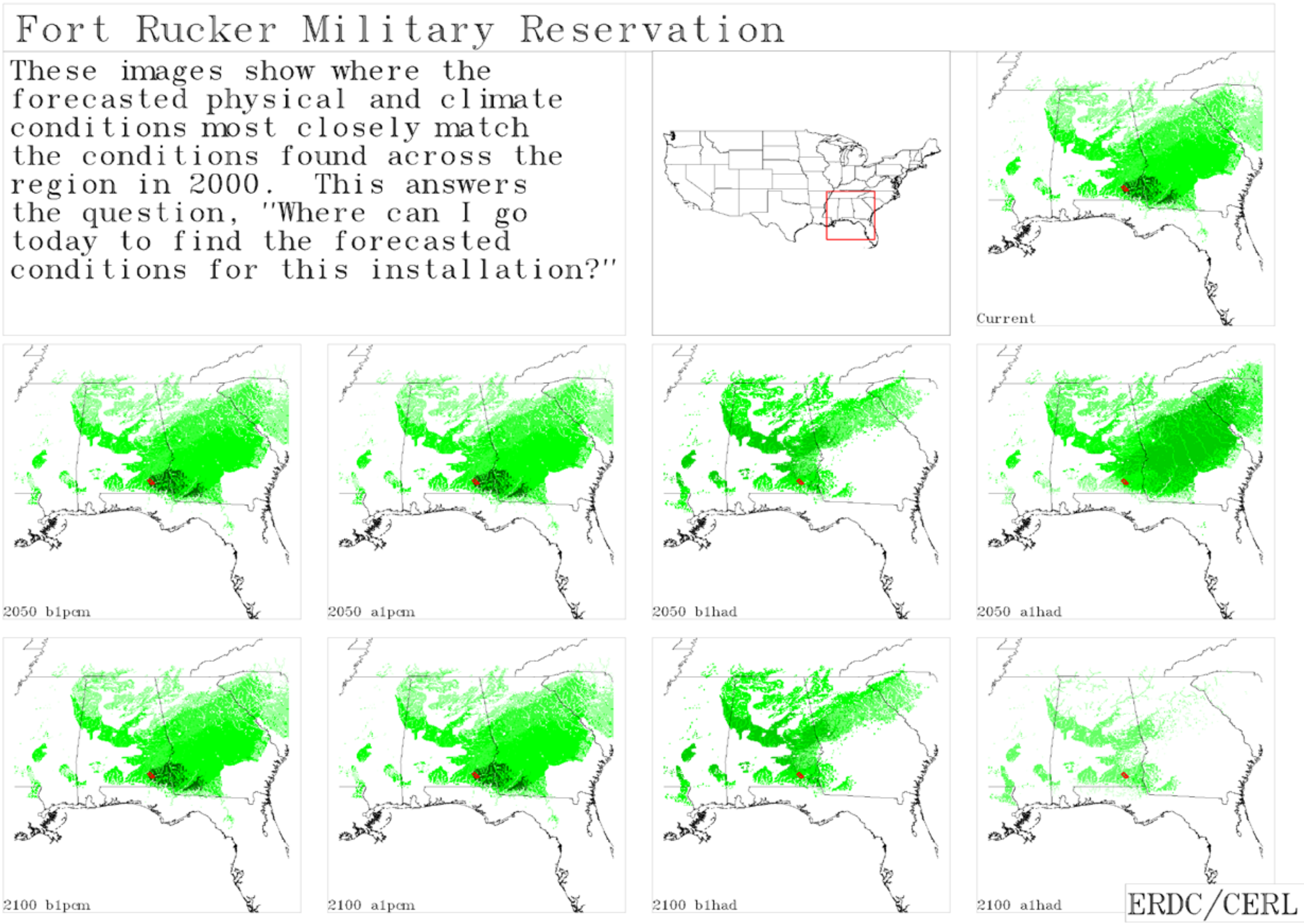

Fort Riley Military Reservation
0) Different from any area in the world in
269) 54% -Southern Shortgrass Prairie
433) 36% -Humid Pampas
748) 86% -Central Mixed-Grass Prairie
750) 48% -Central Tallgrass Prairie
751) 72% -Crosstimbers And Southern Tallgra
753) 53% -Edwards Plateau
757) 90% -Osage Plains/Flint Hills Prairie
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



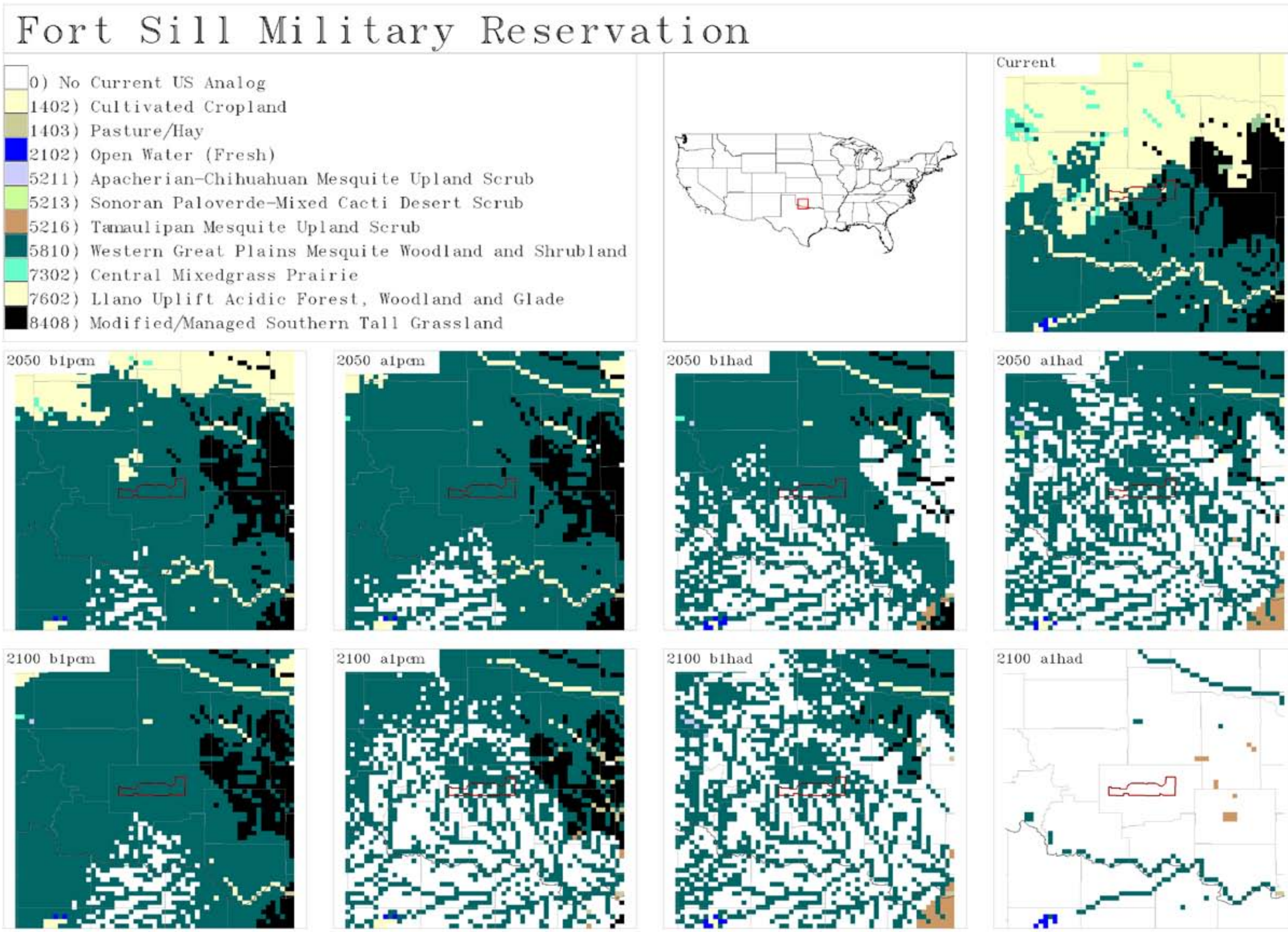
Fort Rucker Military Reservation


Fort Rucker Military Reservation
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
4501) East Gulf Coastal Plain Interior Upland Longleaf Pine Woo
4507) East Gulf Coastal Plain Interior Upland Longleaf Pine Woo
4508) East Gulf Coastal Plain Interior Upland Longleaf Pine Woo
8202) Evergreen Plantations or Managed Pine (can include dense
8203) Managed Tree Plantation
9804) East Gulf Coastal Plain Large River Floodplain Forest - F
9903) East Gulf Coastal Plain Near-Coast Pine Flatwoods - Open
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and Fla
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

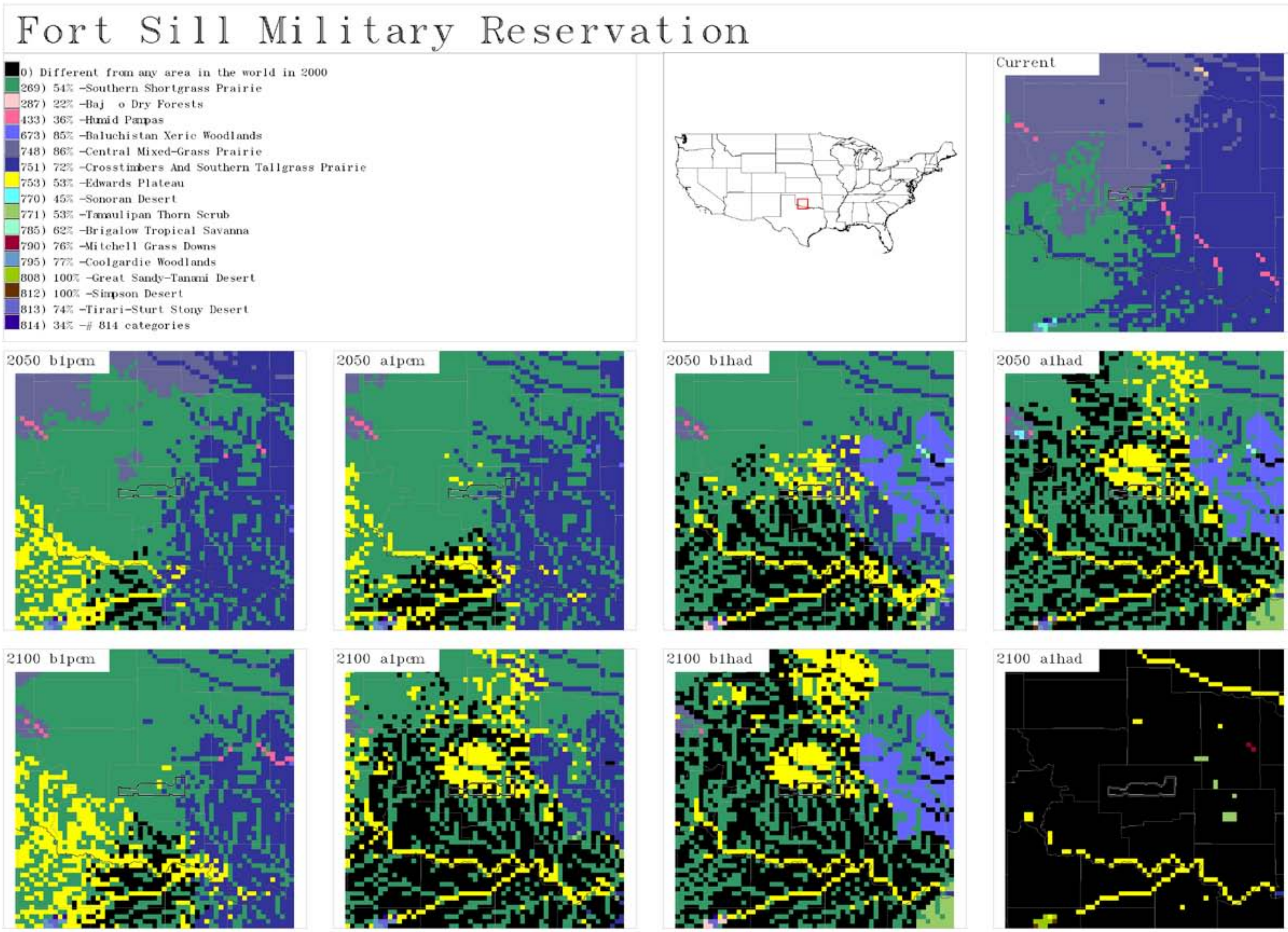

Fort Rucker Military Reservation
0) Different from any area in the world in 2000
98) 47% -Southern Acacia-Commiphora Bushlands And Thickets
293) 71% -Alto Paran Atlantic Forests
294) 64% -Araucaria Moist Forests
301) 100% -Catatumbo Moist Forests
319) 47% -Guianan Moist Forests
499) 90% -East Gulf Coastal Plain
503) 81% -Mid-Atlantic Coastal Plain
707) 30% -Cumberlands And Southern Ridge And Valley
712) 61% -Mississippi River Alluvial Plain
715) 31% -Upper East Gulf Coastal Plain
727) 82% -South Atlantic Coastal Plain
729) 84% -Upper West Gulf Coastal Plain
733) 97% -West Gulf Coastal Plain
746) 100% -Gulf Coast Prairies And Marshes
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

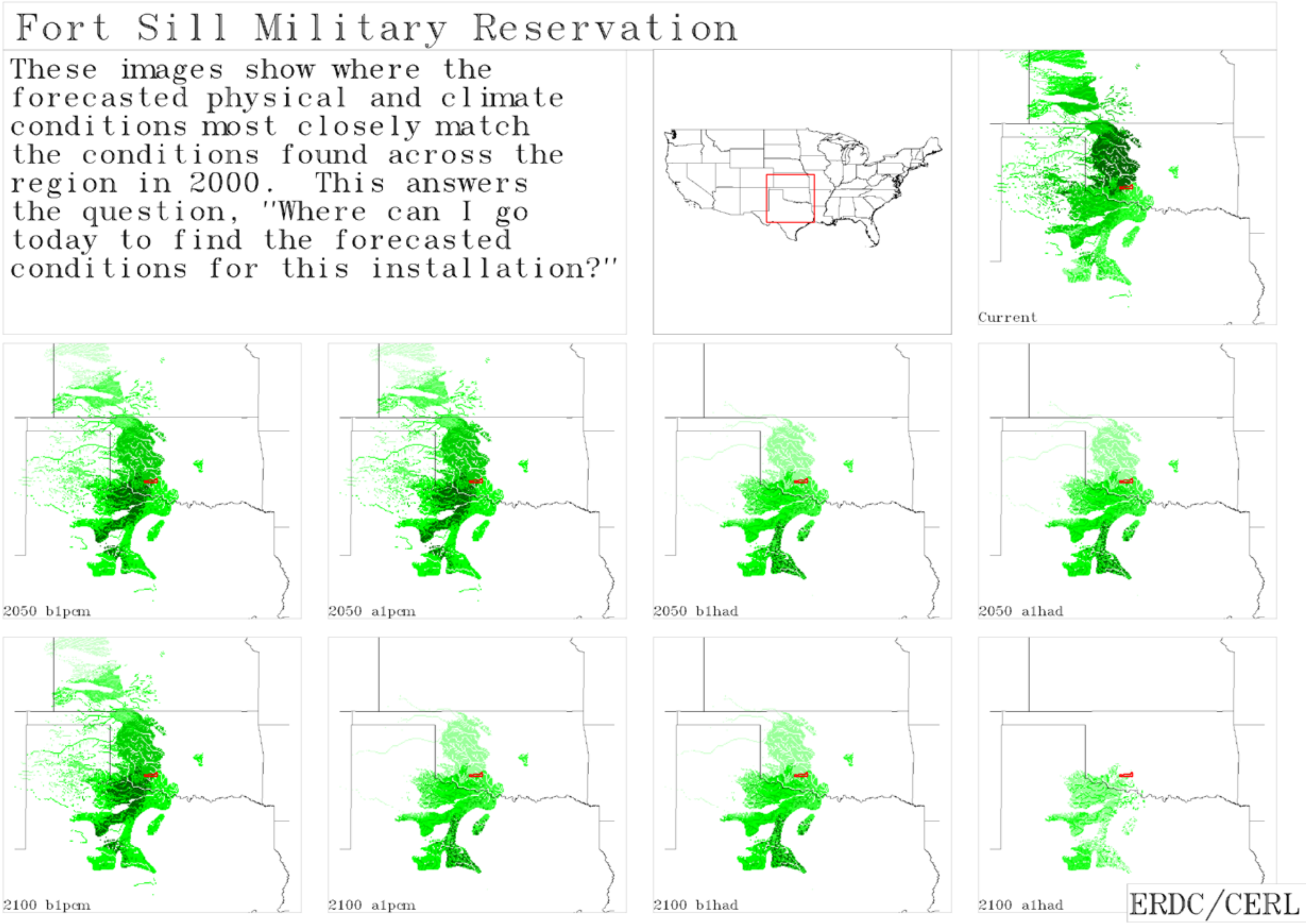


Fort Sill Military Reservation

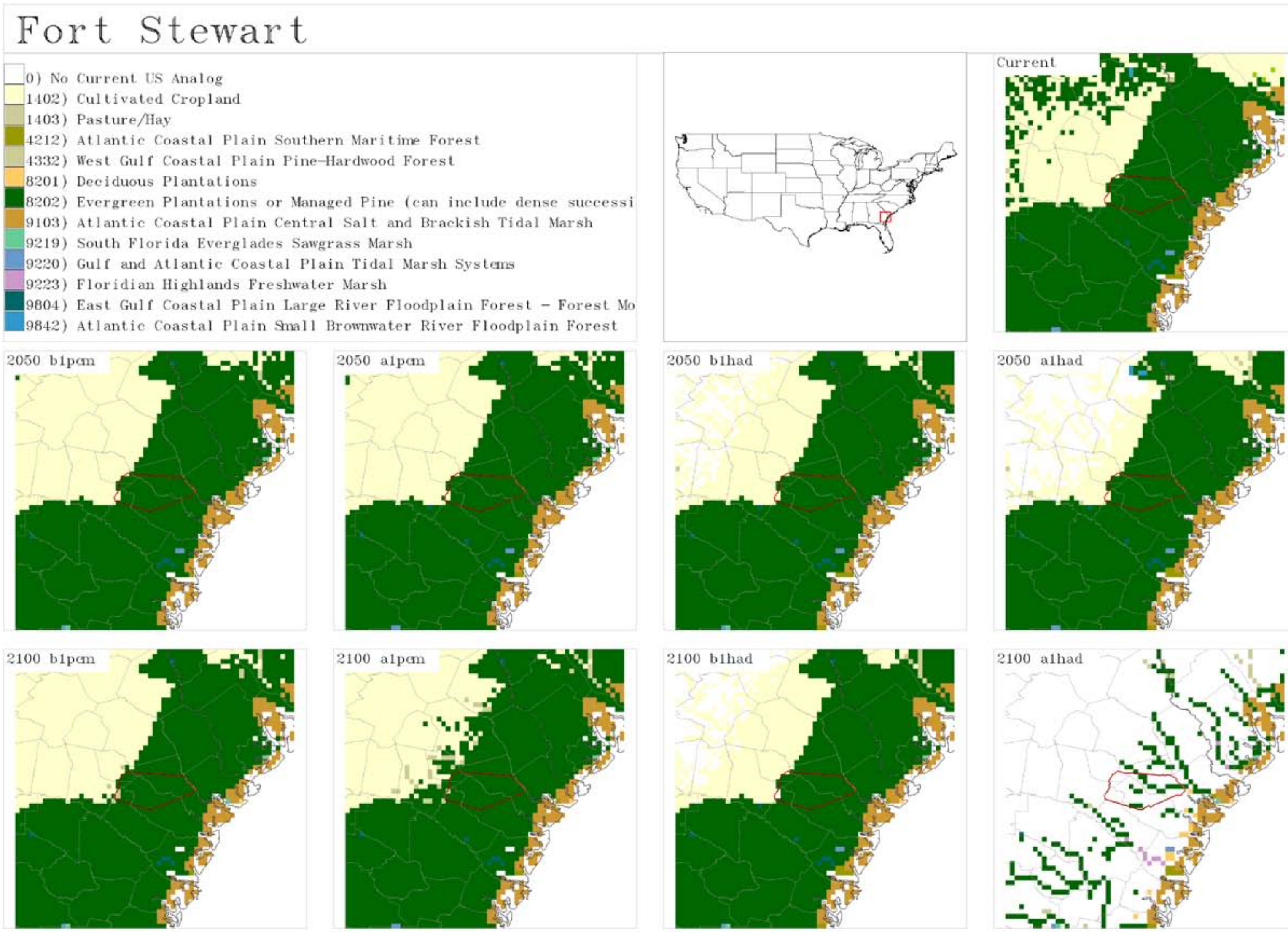


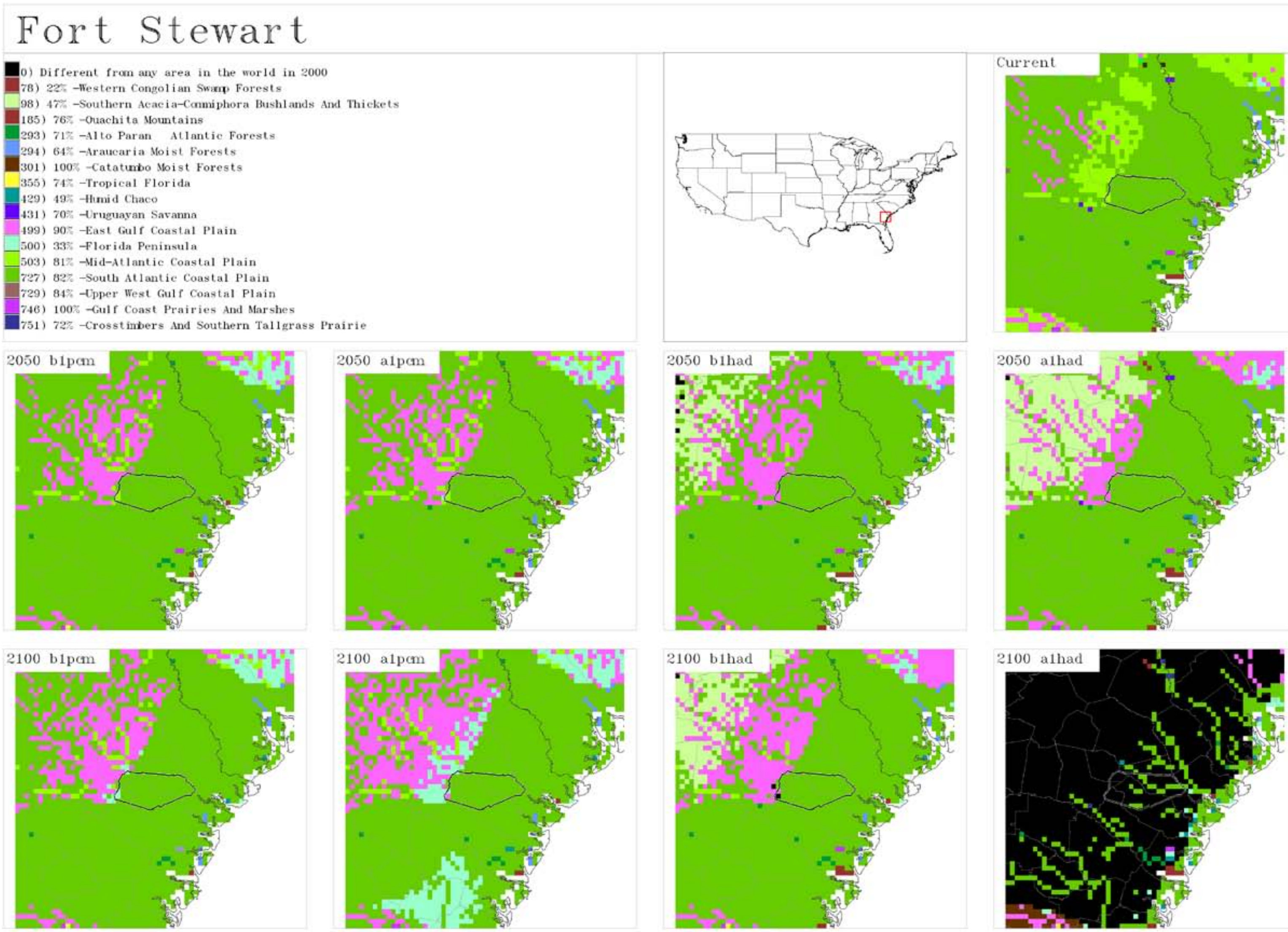
Fort Sill Military Reservation
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
2102) Open Water (Fresh)
5211) Apacherian-Chihuahuan Mesquite Upland Scrub
5213) Sonoran Paloverde-Mixed Cacti Desert Scrub
5216) Tamaulipan Mesquite Upland Scrub
5810) Western Great Plains Mesquite Woodland and Shrubland
7302) Central Mixedgrass Prairie
7602) Llano Uplift Acidic Forest, Woodland and Glade
8408) Modified/Managed Southern Tall Grassland
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

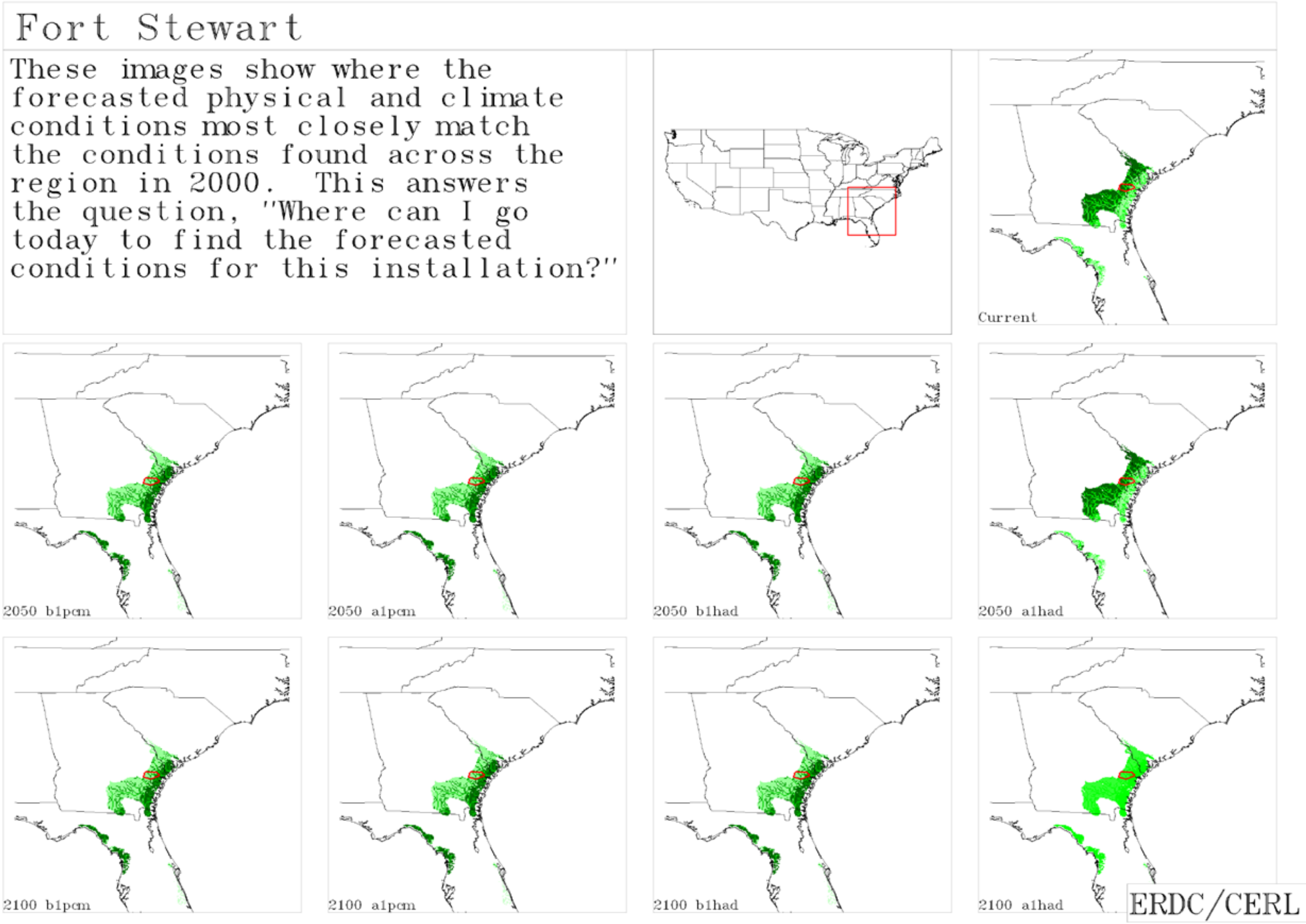

Fort Sill Military Reservation
0) Different from any area in the world in 2000
269) 54% -Southern Shortgrass Prairie
287) 22% -Baj o Dry Forests
433) 36% -Humid Pampas
673) 85% -Baluchistan Xeric Woodlands
748) 86% -Central Mixed-Grass Prairie
751) 72% -Crosstimbers And Southern Tallgrass Prairie
753) 53% -Edwards Plateau
770) 45% -Sonoran Desert
771) 53% -Tamaulipan Thorn Scrub
785) 62% -Brigalow Tropical Savanna
790) 76% -Mitchell Grass Downs
795) 77% -Coolgardie Woodlands
808) 100% -Great Sandy-Tanami Desert
812) 100% -Simpson Desert
813) 74% -Tirari-Sturt Stony Desert
814) 34% -# 814 categories
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



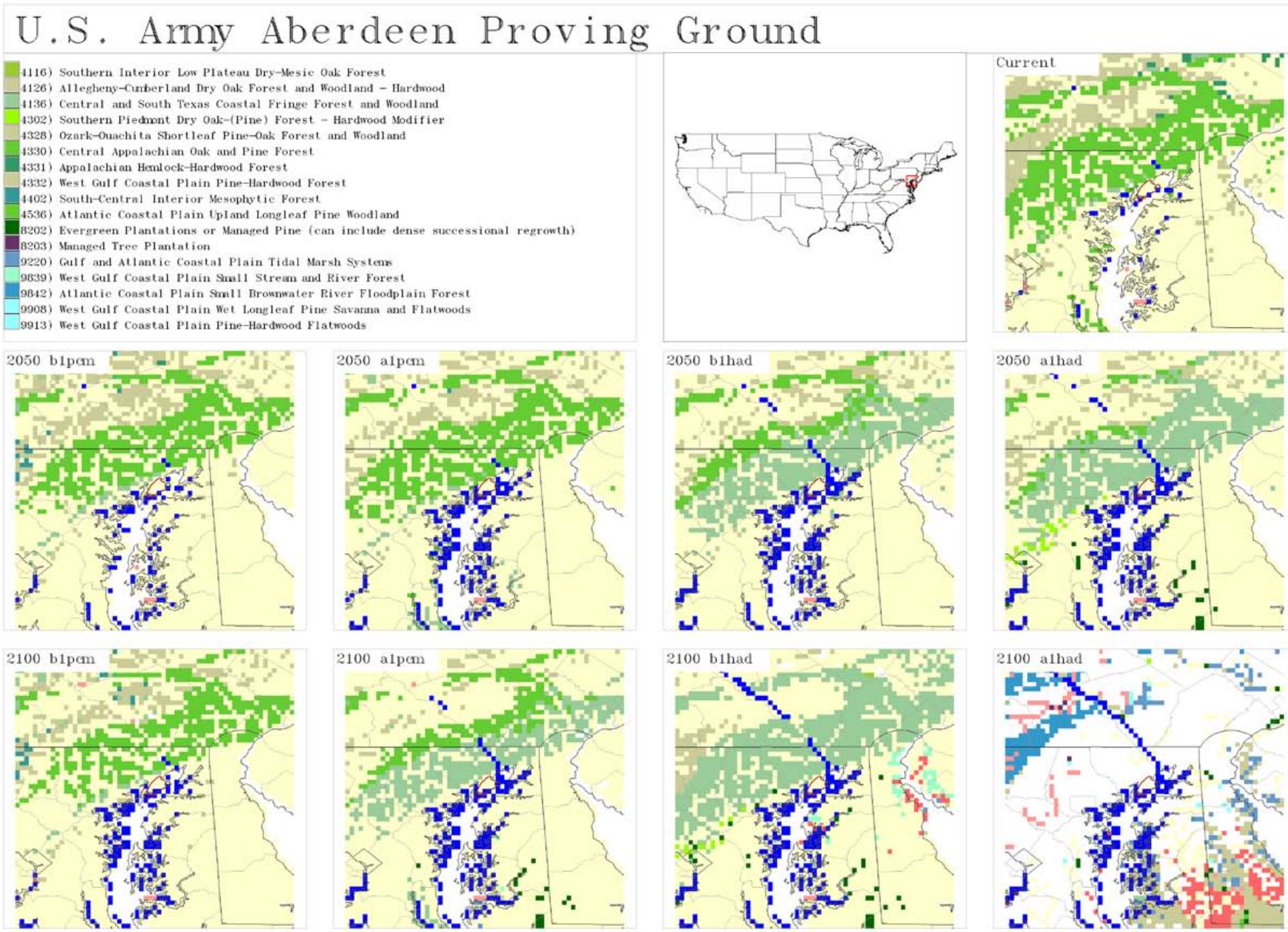
Fort Stewart

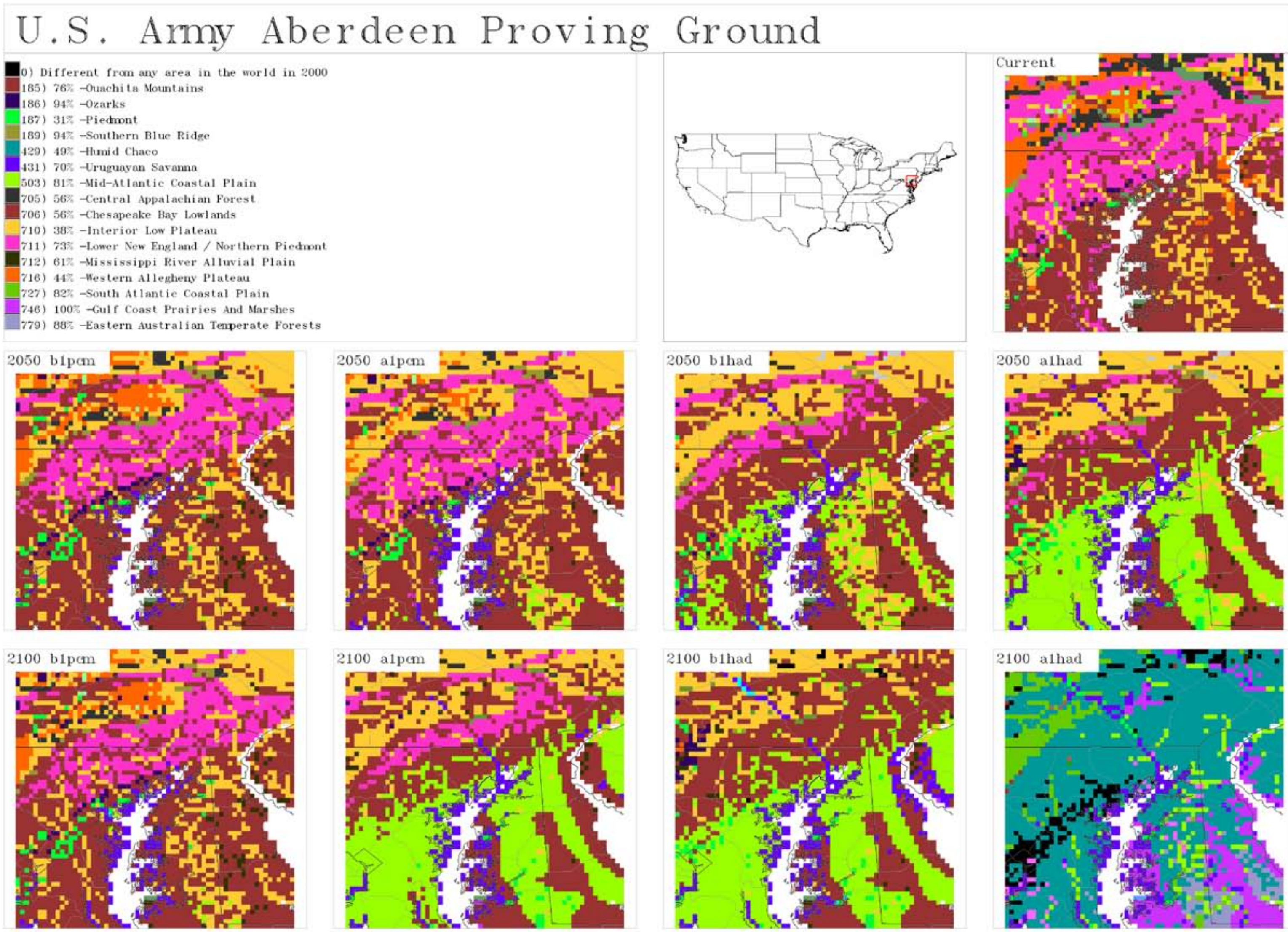

Fort Stewart
0) No Current US Analog
1402) Cultivated Cropland
1403) Pasture/Hay
4212) Atlantic Coastal Plain Southern Maritime Forest
4332) West Gulf Coastal Plain Pine-Hardwood Forest
8201) Deciduous Plantations
8202) Evergreen Plantations or Managed Pine (can include dense successi
9103) Atlantic Coastal Plain Central Salt and Brackish Tidal Marsh
9219) South Florida Everglades Sawgrass Marsh
9220) Gulf and Atlantic Coastal Plain Tidal Marsh Systems
9223) Floridian Highlands Freshwater Marsh
9804) East Gulf Coastal Plain Large River Floodplain Forest - Forest Mo
9842) Atlantic Coastal Plain Small Brownwater River Floodplain Forest
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

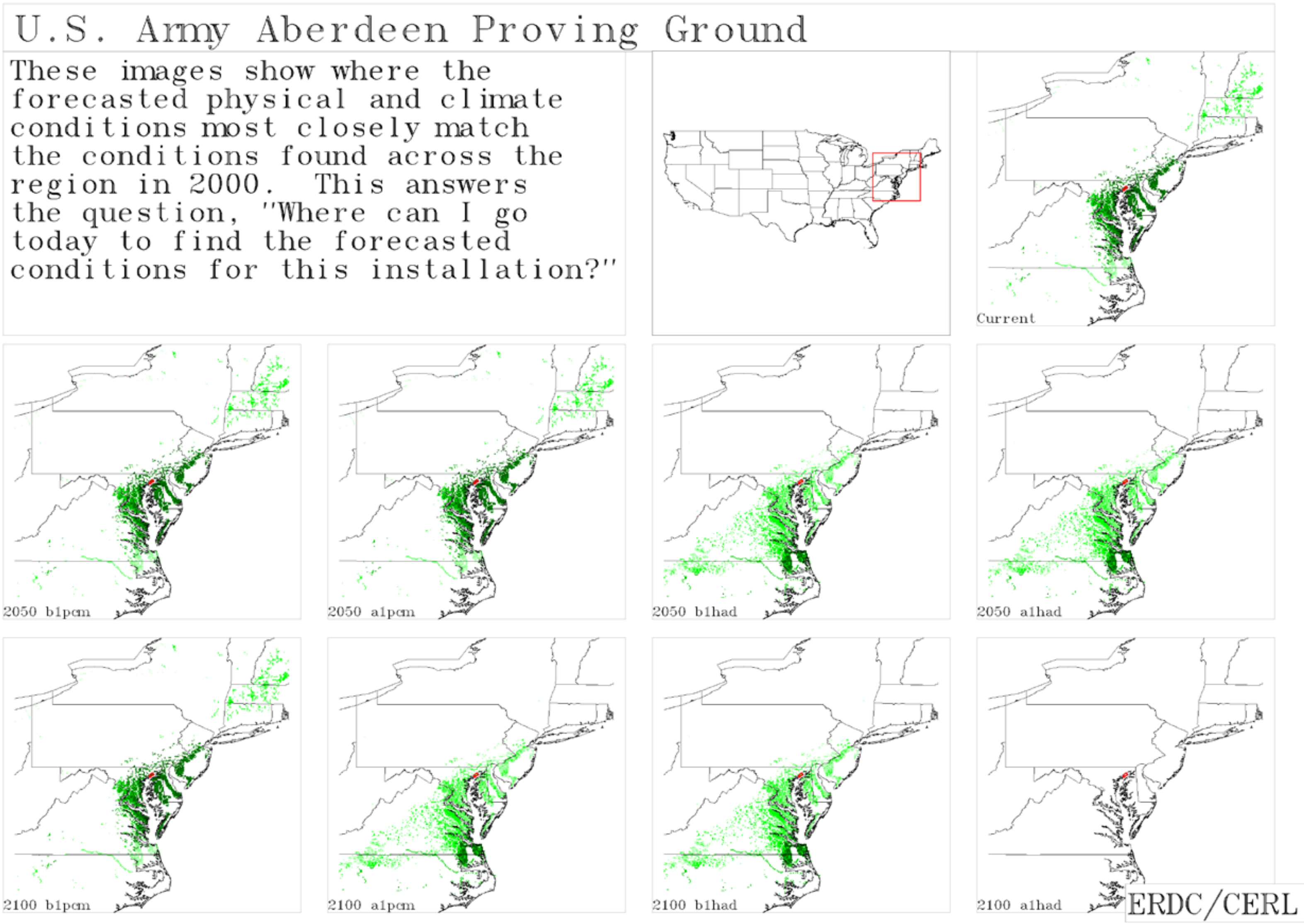

Fort Stewart
0) Different from any area in the world in 2000
78) 22% -Western Congolian Swamp Forests
98) 47% -Southern Acacia-Commiphora Bushlands And Thickets
185) 76% -Ouachita Mountains
293) 71% -Alto Paran Atlantic Forests
294) 64% -Araucaria Moist Forests
301) 100% -Catatumbo Moist Forests
355) 74% -Tropical Florida
429) 49% -Humid Chaco
431) 70% -Uruguayan Savanna
499) 90% -East Gulf Coastal Plain
500) 33% -Florida Peninsula
503) 81% -Mid-Atlantic Coastal Plain
727) 82% -South Atlantic Coastal Plain
729) 84% -Upper West Gulf Coastal Plain
746) 100% -Gulf Coast Prairies And Marshes
751) 72% -Crosstimbers And Southern Tallgrass Prairie
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



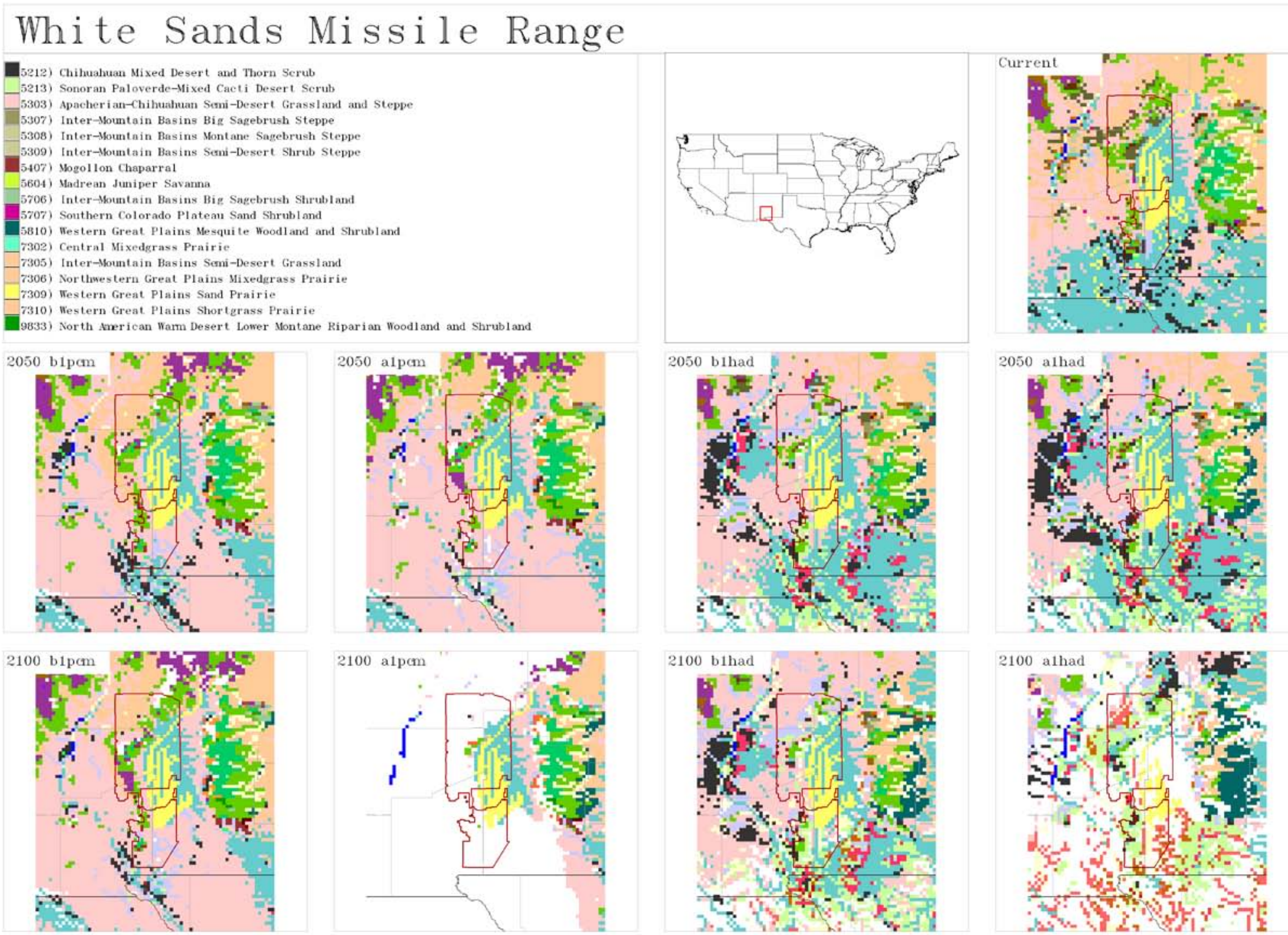
U.S. Army Aberdeen Proving Ground

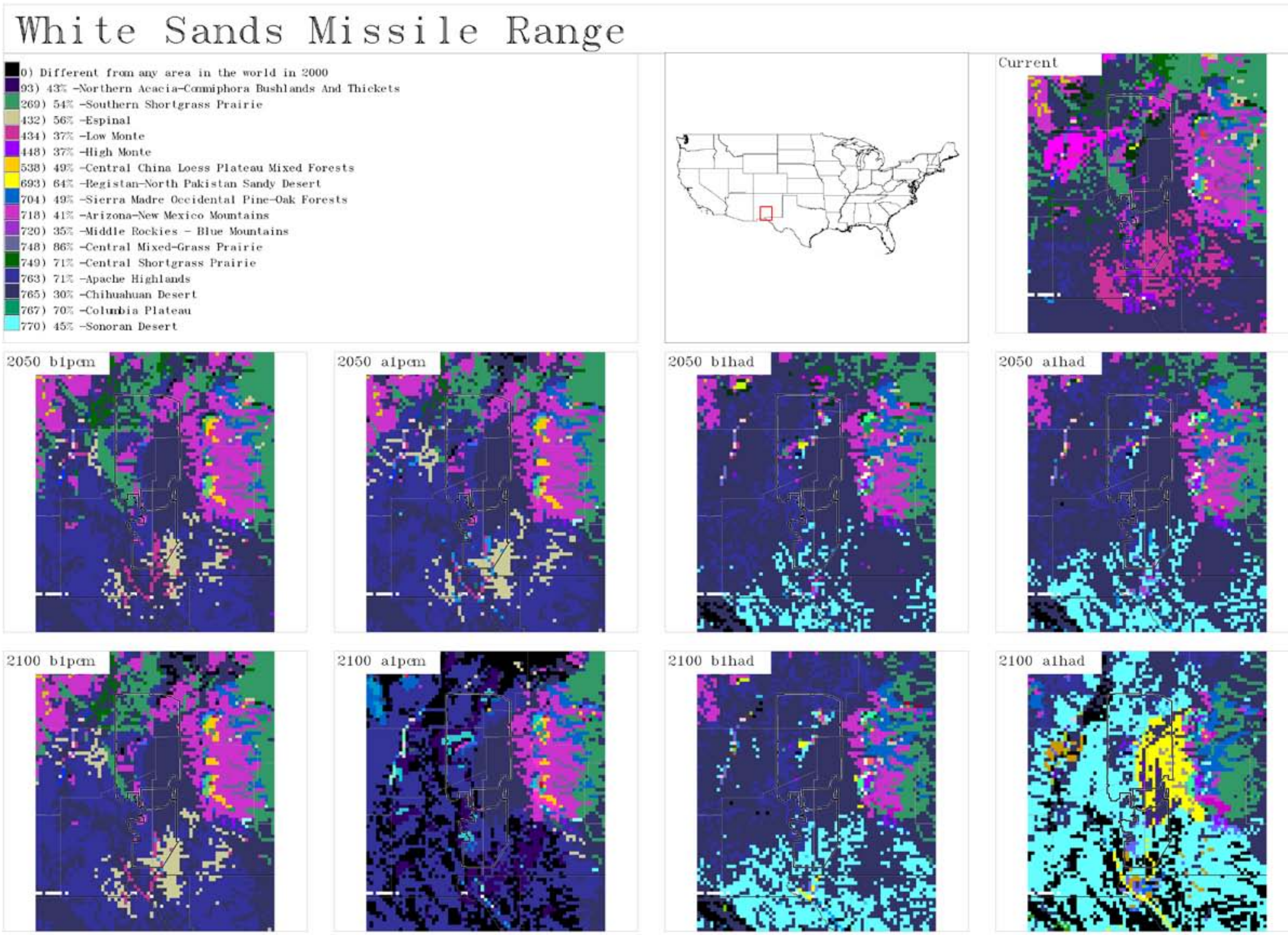

U.S. Army Aberdeen Proving Ground
4116) Southern Interior Low Plateau Dry-Mesic Oak Forest
4126) Allegheny-Cumberland Dry Oak Forest and Woodland - Hardwood
4136) Central and South Texas Coastal Fringe Forest and Woodland
4302) Southern Piedmont Dry Oak-(Pine) Forest - Hardwood Modifier
4328) Ozark-Ouachita Shortleaf Pine-Oak Forest and Woodland
4330) Central Appalachian Oak and Pine Forest
4331) Appalachian Hemlock-Hardwood Forest
4332) West Gulf Coastal Plain Pine-Hardwood Forest
4402) South-Central Interior Mesophytic Forest
4536) Atlantic Coastal Plain Upland Longleaf Pine Woodland
8202) Evergreen Plantations or Managed Pine (can include dense successional regrowth)
8203) Managed Tree Plantation
9220) Gulf and Atlantic Coastal Plain Tidal Marsh Systems
9839) West Gulf Coastal Plain Small Stream and River Forest
9842) Atlantic Coastal Plain Small Brownwater River Floodplain Forest
9908) West Gulf Coastal Plain Wet Longleaf Pine Savanna and Flatwoods
9913) West Gulf Coastal Plain Pine-Hardwood Flatwoods
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

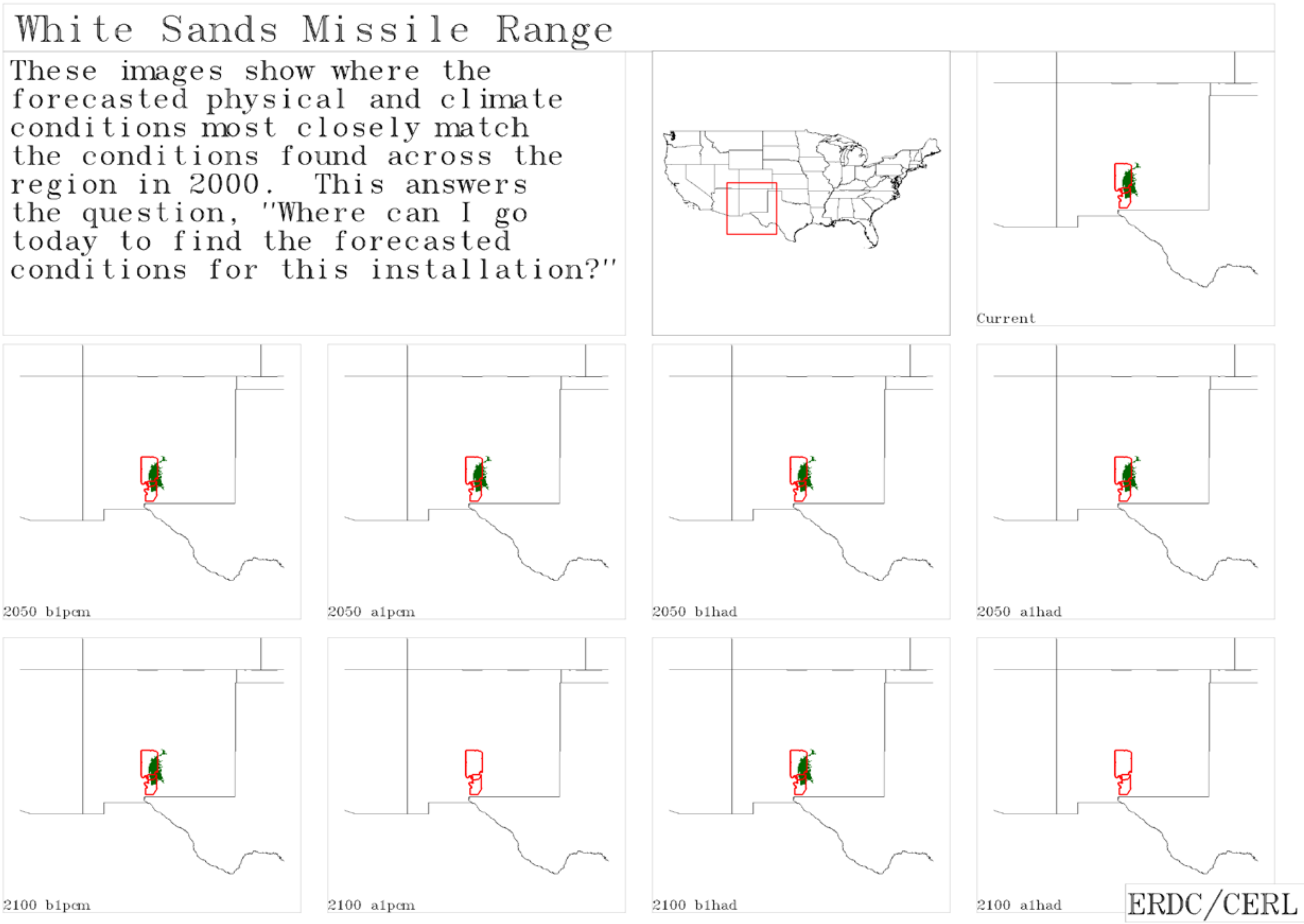

U.S. Army Aberdeen Proving Ground
0) Different from any area in the world in 2000
185) 76% -Ouachita Mountains
186) 94% -Ozarks
187) 31% -Piedmont
189) 94% -Southern Blue Ridge
429) 49% -Humid Chaco
431) 70% -Uruguayan Savanna
503) 81% -Mid-Atlantic Coastal Plain
705) 56% -Central Appalachian Forest
706) 56% -Chesapeake Bay Lowlands
710) 38% -Interior Low Plateau
711) 73% -Lower New England / Northern Piedmont
712) 61% -Mississippi River Alluvial Plain
716) 44% -Western Allegheny Plateau
727) 82% -South Atlantic Coastal Plain
746) 100% -Gulf Coast Prairies And Marshes
779) 88% -Eastern Australian Temperate Forests
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



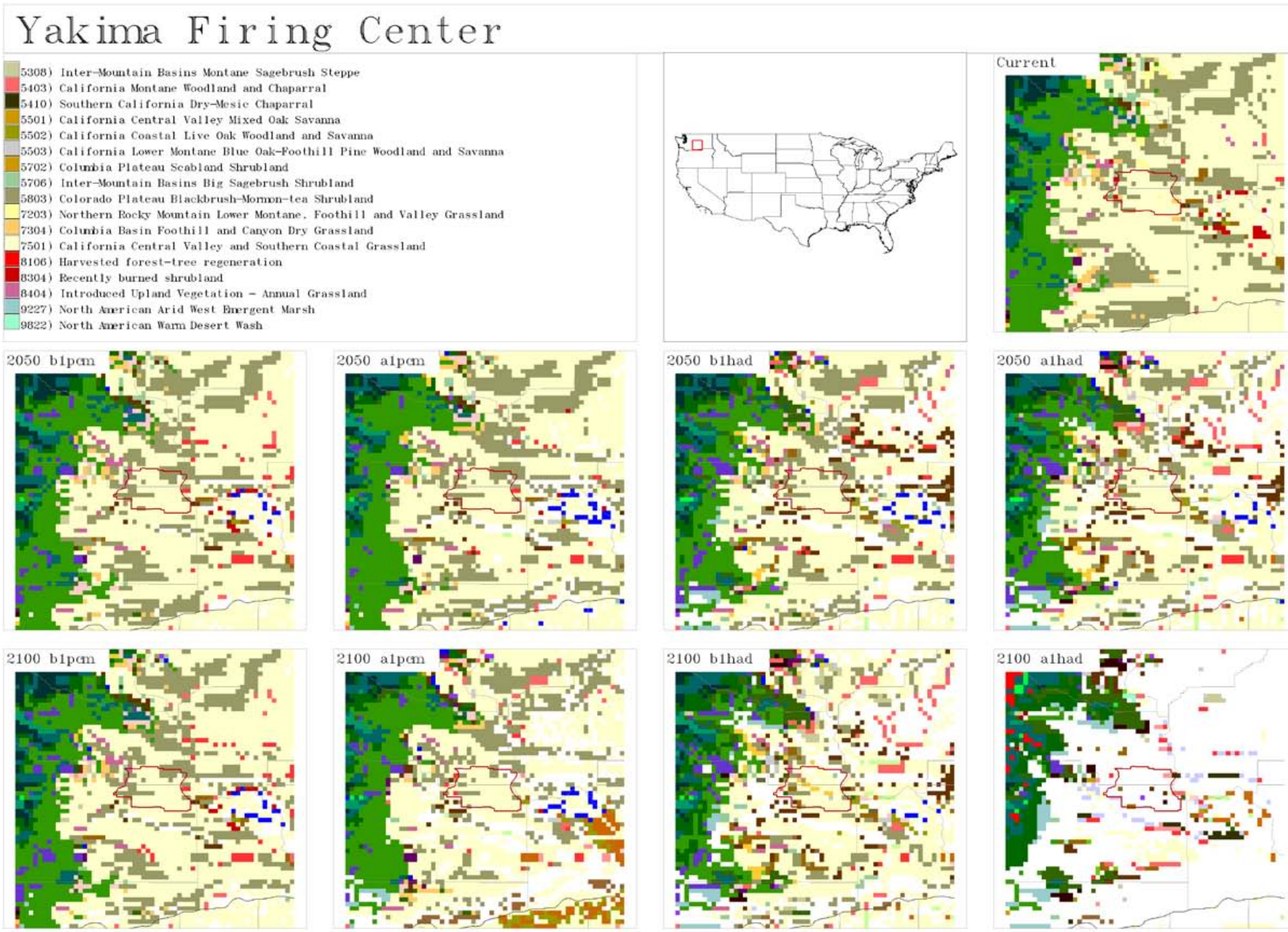
White Sands Missile Range

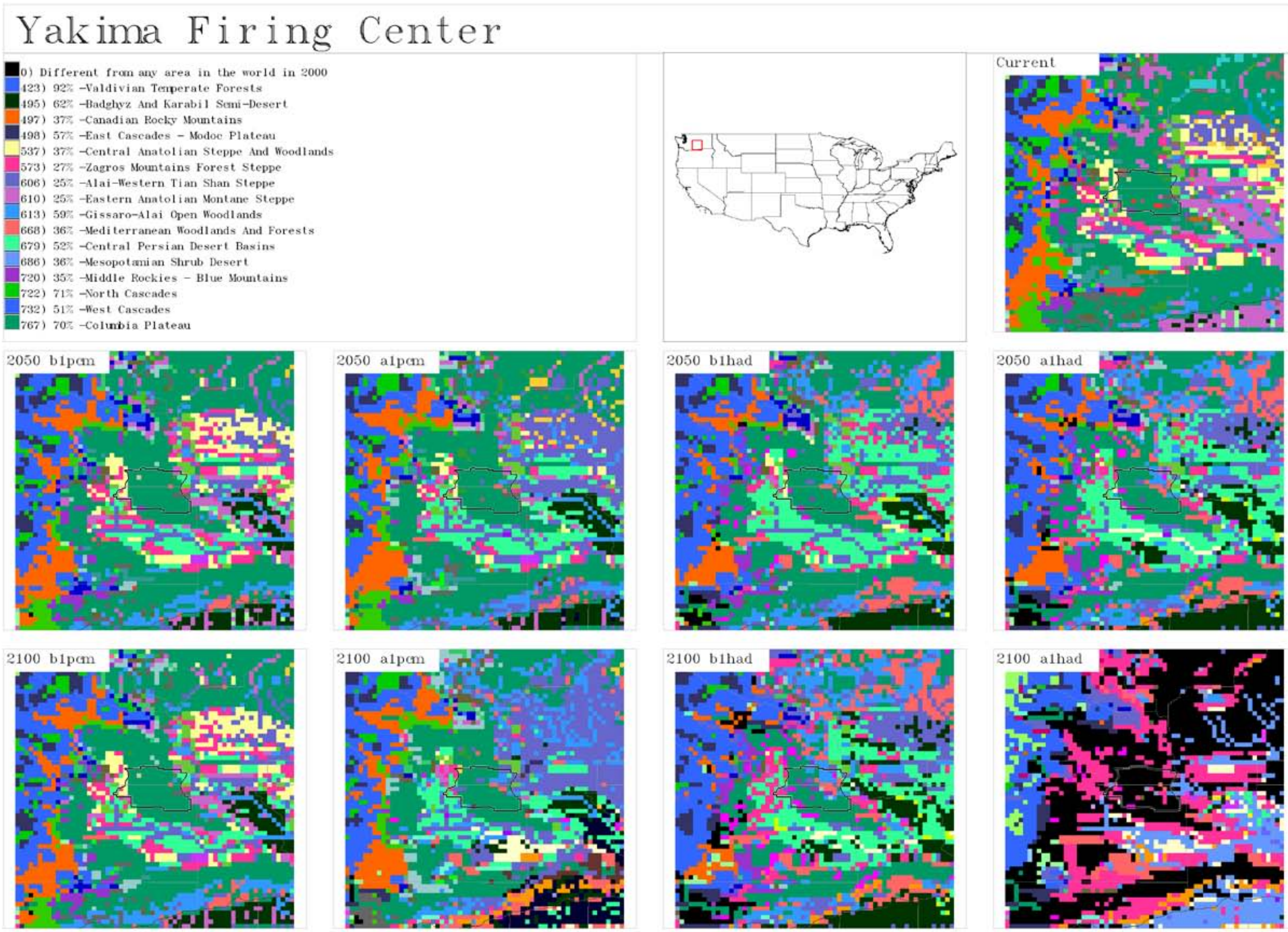

White Sands Missile Range
5212) Chihuahuan Mixed Desert and Thorn Scrub
5213) Sonoran Paloverde-Mixed Cacti Desert Scrub
5303) Apacherian-Chihuahuan Semi-Desert Grassland and Steppe
5307) Inter-Mountain Basins Big Sagebrush Steppe
5308) Inter-Mountain Basins Montane Sagebrush Steppe
5309) Inter-Mountain Basins Semi-Desert Shrub Steppe
5407) Mogollon Chaparral
5604) Madrean Juniper Savanna
5706) Inter-Mountain Basins Big Sagebrush Shrubland
5707) Southern Colorado Plateau Sand Shrubland
5810) Western Great Plains Mesquite Woodland and Shrubland
7302) Central Mixedgrass Prairie
7305) Inter-Mountain Basins Semi-Desert Grassland
7306) Northwestern Great Plains Mixedgrass Prairie
7309) Western Great Plains Sand Prairie
7310) Western Great Plains Shortgrass Prairie
9833) North American Warm Desert Lower Montane Riparian Woodland and Shrubland
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

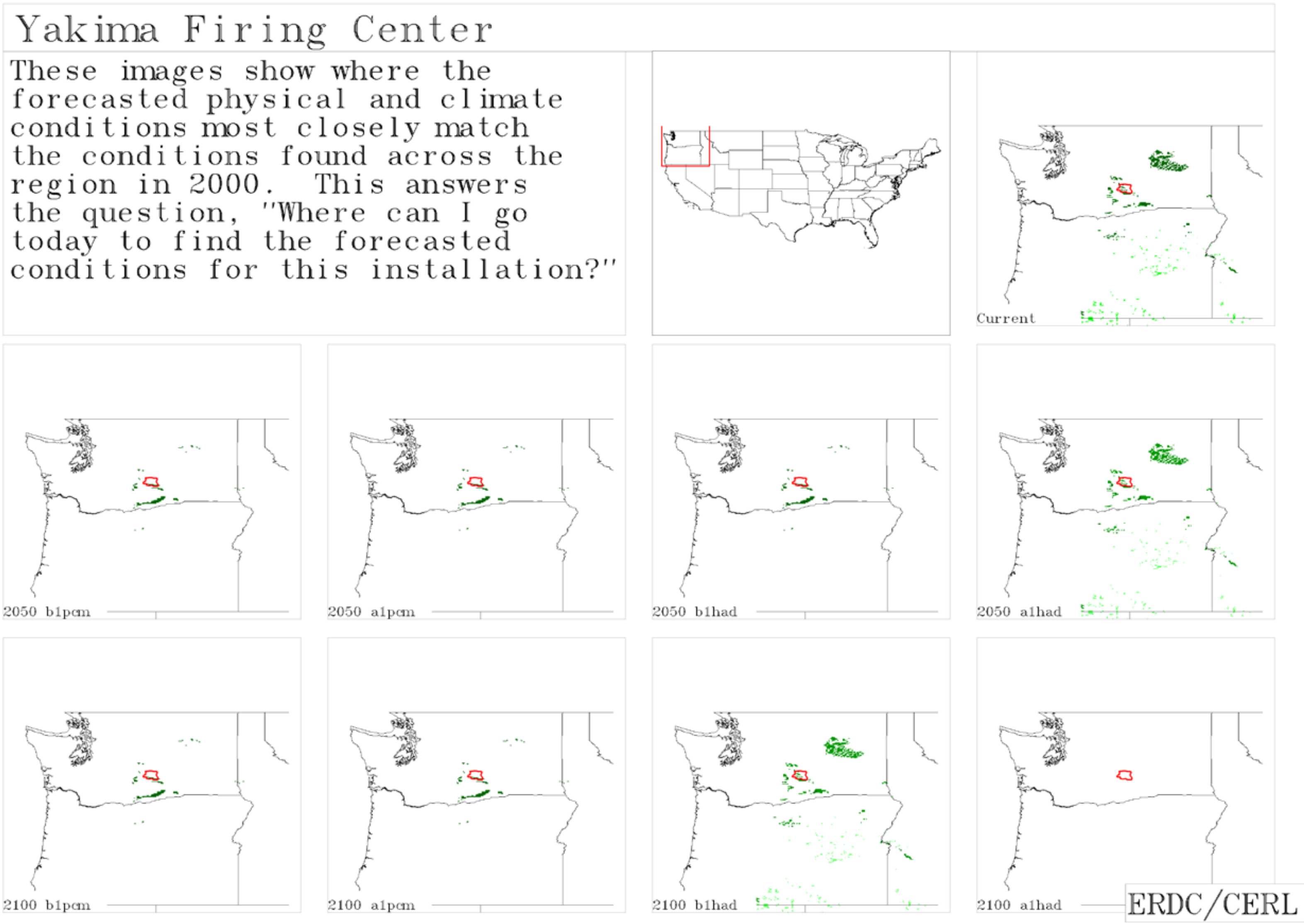

White Sands Missile Range
0) Different from any area in the world in 2000
93) 43% -Northern Acacia-Commiphora Bushlands And Thickets
269) 54% -Southern Shortgrass Prairie
432) 56% -Espinal
434) 37% -Low Monte
448) 37% -High Monte
538) 49% -Central China Loess Plateau Mixed Forests
693) 64% -Registan-North Pakistan Sandy Desert
704) 49% -Sierra Madre Occidental Pine-Oak Forests
718) 41% -Arizona-New Mexico Mountains
720) 35% -Middle Rockies - Blue Mountains
748) 86% -Central Mixed-Grass Prairie
749) 71% -Central Shortgrass Prairie
763) 71% -Apache Highlands
765) 30% -Chihuahuan Desert
767) 70% -Columbia Plateau
770) 45% -Sonoran Desert
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



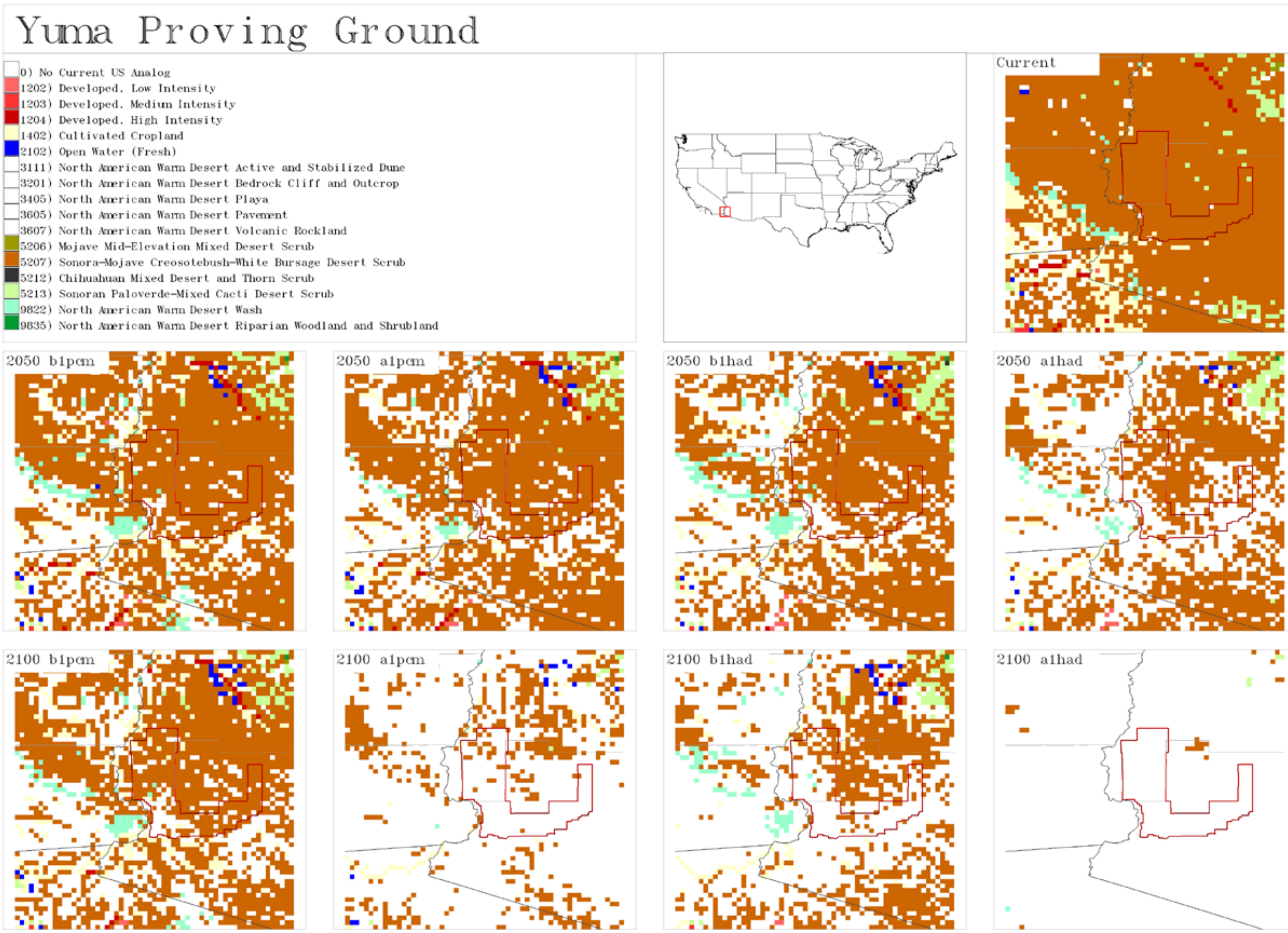
Yakima Firing Center

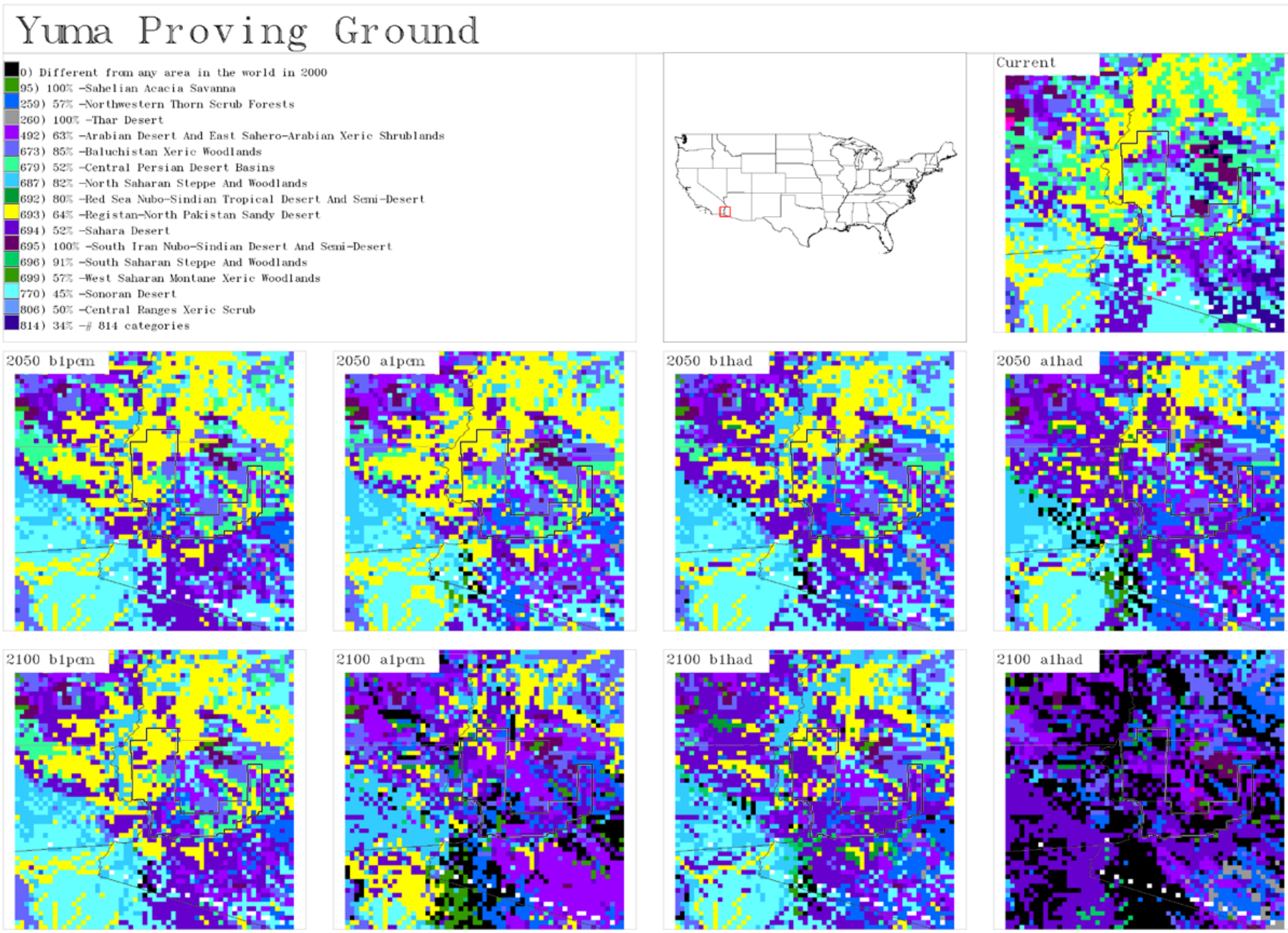

Yakima Firing Center
5308) Inter-Mountain Basins Montane Sagebrush Steppe
5403) California Montane Woodland and Chaparral
5410) Southern California Dry-Mesic Chaparral
5501) California Central Valley Mixed Oak Savanna
5502) California Coastal Live Oak Woodland and Savanna
5503) California Lower Montane Blue Oak-Foothill Pine Woodland and Savanna
5702) Columbia Plateau Scabland Shrubland
5706) Inter-Mountain Basins Big Sagebrush Shrubland
5803) Colorado Plateau Blackbrush-Mormon-tea Shrubland
7203) Northern Rocky Mountain Lower Montane, Foothill and Valley Grassland
7304) Columbia Basin Foothill and Canyon Dry Grassland
7501) California Central Valley and Southern Coastal Grassland
8106) Harvested forest-tree regeneration
8304) Recently burned shrubland
8404) Introduced Upland Vegetation - Annual Grassland
9227) North American Arid West Emergent Marsh
9822) North American Warm Desert Wash
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had

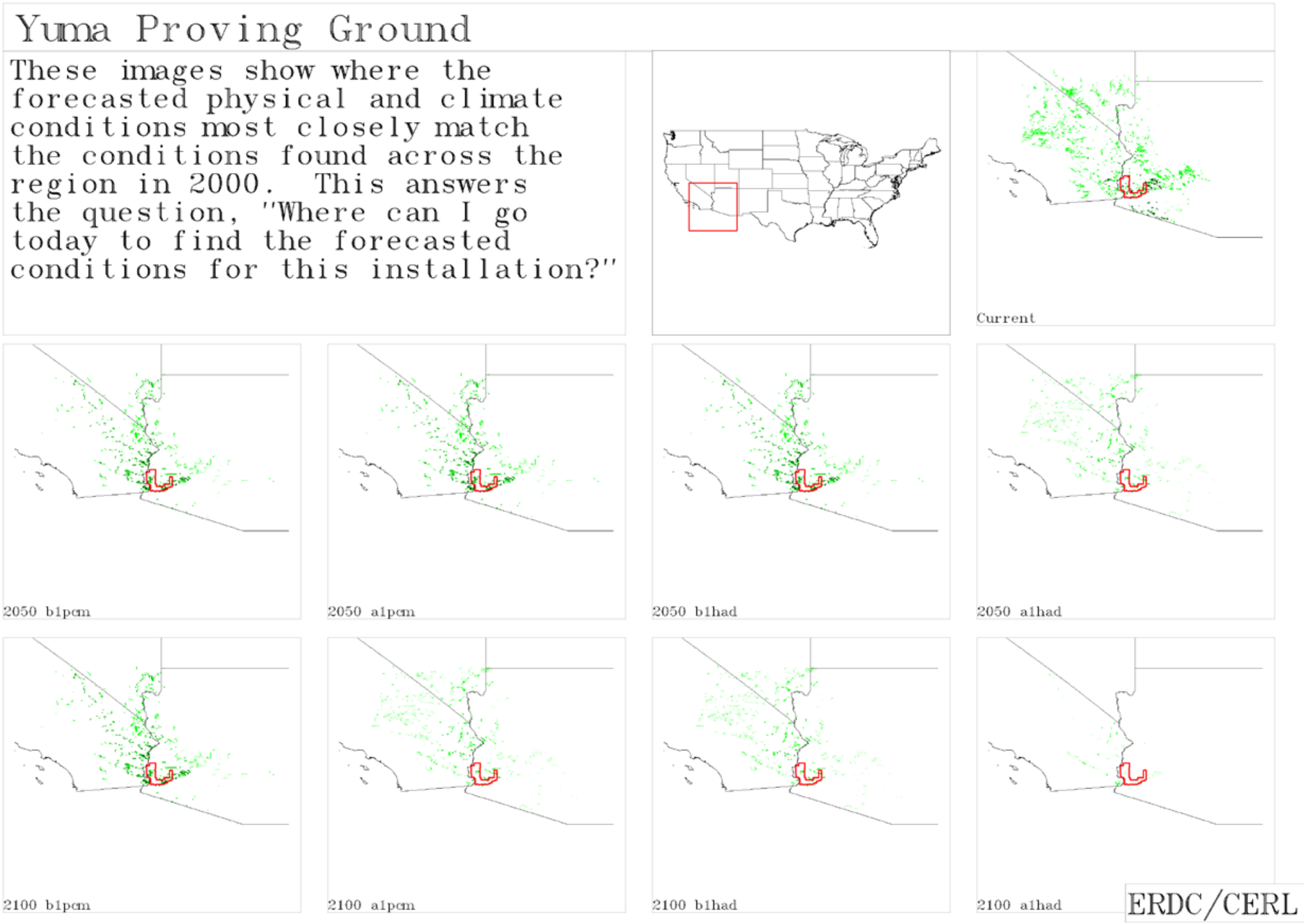

Yakima Firing Center
0) Different from any area in the world in 2000
423) 92% -Valdivian Temperate Forests
495) 62% -Badghyz And Karabil Semi-Desert
497) 37% -Canadian Rocky Mountains
498) 57% -East Cascades - Modoc Plateau
537) 37% -Central Anatolian Steppe And Woodlands
573) 27% -Zagros Mountains Forest Steppe
606) 25% -Alai-Western Tian Shan Steppe
610) 25% -Eastern Anatolian Montane Steppe
613) 59% -Gissaro-Alai Open Woodlands
668) 36% -Mediterranean Woodlands And Forests
679) 52% -Central Persian Desert Basins
686) 36% -Mesopotamian Shrub Desert
720) 35% -Middle Rockies - Blue Mountains
722) 71% -North Cascades
732) 51% -West Cascades
767) 70% -Columbia Plateau
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had



Yuma Proving Ground


Yuma Proving Ground
0) No Current US Analog
1202) Developed, Low Intensity
1203) Developed, Medium Intensity
1204) Developed, High Intensity
1402) Cultivated Cropland
2102) Open Water (Fresh)
3111) North American Warm Desert Active and Stabilized Dune
3201) North American Warm Desert Bedrock Cliff and Outcrop
3405) North American Warm Desert Playa
3605) North American Warm Desert Pavement
3607) North American Warm Desert Volcanic Rockland
5206) Mojave Mid-Elevation Mixed Desert Scrub
5207) Sonora-Mojave Creosotebush-White Bursage Desert Scrub
5212) Chihuahuan Mixed Desert and Thorn Scrub
5213) Sonoran Paloverde-Mixed Cacti Desert Scrub
9822) North American Warm Desert Wash
9835) North American Warm Desert Riparian Woodland and Shrubland
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Yuma Proving Ground
0) Different from any area in the world in 2000
95) 100% -Sahelian Acacia Savanna
259) 57% -Northwestern Thorn Scrub Forests
260) 100% -Thar Desert
492) 63% -Arabian Desert And East Sahero-Arabian Xeric Shrublands
673) 85% -Baluchistan Xeric Woodlands
679) 52% -Central Persian Desert Basins
687) 82% -North Saharan Steppe And Woodlands
692) 80% -Red Sea Nubo-Sindian Tropical Desert And Semi-Desert
693) 64% -Registan-North Pakistan Sandy Desert
694) 52% -Sahara Desert
695) 100% -South Iran Nubo-Sindian Desert And Semi-Desert
696) 91% -South Saharan Steppe And Woodlands
699) 57% -West Saharan Montane Xeric Woodlands
770) 45% -Sonoran Desert
806) 50% -Central Ranges Xeric Scrub
814) 34% -# 814 categories
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had


Yuma Proving Ground
These images show where the forecasted physical and climate conditions most closely match the conditions found across the region in 2000. This answers the question, "Where can I go today to find the forecasted conditions for this installation?"
Current
2050 b1pcm
2050 a1pcm
2050 b1had
2050 a1had
2100 b1pcm
2100 a1pcm
2100 b1had
2100 a1had
ERDC/CERL

Appendix C: Ranking Army Installations

Which installations are most at-risk for change due to the consequences of potential ecosystem shift? To rank-order installations, the boundary of each installation was used to "cookie-cutter" into the current and future maps over the eight future GAP-based maps to tabulate the ecosystem type and amount of each type. For each future map, the percent of the installation that still held the current ecosystem types was calculated. The percentage across all eight future maps was then averaged and used to rank-order the installations. The following table lists all of the Army installations ranked by their "risk for change," beginning with the least changeable and ending with the installations likely to be most dramatically affected.

The change counts for each of the model/scenario/time combination are listed in the columns with the average of these (not listed) used to sort the table. The color-breaks are arbitrarily set at 80 and 50 percent.

Legend:
Percent Habit Unchanged By Climate Change
80-100% unchanged
50-80% unchanged
0-50% unchanged

		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	**Size (0.02 x 0.02) degree cells**	**PCM B1 2050**	**PCM B1 2080**	**PCM A1 2050**	**PCM A1 2080**	**HAD B1 2050**	**HAD B1 2080**	**HAD A1 2050**	**HAD A1 2080**
Camp Adair Military Reservation	2	100	100	100	100	100	100	100	100
Hunter Army Airfield	77	100	100	100	100	100	100	100	21
Fort Stewart	2294	100	97	100	95	100	99	100	14
Arlington National Cemetery	4	100	100	100	100	100	100	100	0
Army Reserve Outdoor Training Area	4	100	100	100	100	100	100	100	0
Army Training Area	20	100	100	100	100	100	100	100	0
Globecom Radio Receiving Station	15	100	100	100	100	100	100	100	0
Kearney Rifle Range	8	100	100	100	100	100	100	100	0
LaPorte Outdoor Training Facility	6	100	100	100	100	100	100	100	0
Malabar Transmitter Annex	4	100	100	100	100	100	100	100	0
US Army Reserve Center	4	100	100	100	100	100	100	100	0
Florence Military Reservation	56	100	100	89	79	89	89	89	63
Camp Grayling Military Reservation	2451	97	97	97	97	97	94	97	13
Savanna Army Depot (Scheduled to close)	228	100	100	100	95	97	95	95	0
Fort Irwin	5112	91	91	95	88	90	86	92	46
Fort Belvoir Military Reservation	110	100	100	97	90	90	69	90	29
Camp Roberts Military Reservation	425	95	91	100	97	91	84	89	10

Legend:
Percent Habit Unchanged By Climate Change
80-100% unchanged
50-80% unchanged
0-50% unchanged

		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	Size (0.02 x 0.02) degree cells	PCM B1 2050	PCM B1 2080	PCM A1 2050	PCM A1 2080	HAD B1 2050	HAD B1 2080	HAD A1 2050	HAD A1 2080
Fort Detrick	8	100	100	100	100	100	50	100	0
Badger Army Ammunition Plant	35	100	100	100	100	83	83	83	0
Fort William H. Harrison Military Reservation	30	100	100	100	100	100	70	70	0
Fort George G. Meade	56	100	100	100	79	100	79	79	0
Cornhusker Army Ammunition Plant	8	100	100	100	100	100	100	25	0
Bearmouth National Guard Training Area	15	100	100	100	73	100	67	67	13
Joliet Army Ammunition Plant	182	100	100	100	52	100	77	88	0
Custer Reserve Forces Training Area	96	100	100	100	51	100	78	78	0
Fort Riley Military Reservation	1280	98	98	98	98	95	54	60	0
Buckeye National Guard Target Range	10	100	100	100	0	100	100	100	0
Fitzsimons Army Medical Center (Closed)	4	100	50	50	50	100	100	100	50
Natick Laboratories Military Reservation	36	100	100	100	0	100	100	100	0
Louisiana Ordnance Plant	95	92	92	92	75	75	62	75	0
Nap of the Earth Army Helicopter Training Are	5338	75	73	73	71	72	71	70	50
Camp Dodge Military Reservation	25	100	100	100	32	24	92	92	0
Fort Pickett Military Reservation (Closed)	352	97	97	88	91	91	18	53	0
Sharpe General Depot (Field Annex)	3	100	100	100	100	67	67	0	0

Legend:
Percent Habit Unchanged By Climate Change
80-100% unchanged
50-80% unchanged
0-50% unchanged

		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	**Size (0.02 x 0.02) degree cells**	**PCM B1 2050**	**PCM B1 2080**	**PCM A1 2050**	**PCM A1 2080**	**HAD B1 2050**	**HAD B1 2080**	**HAD A1 2050**	**HAD A1 2080**
Fort McCoy	713	100	100	100	98	50	47	34	0
Newport Army Ammunition Plant	24	100	100	100	100	75	25	25	0
Dugway Proving Grounds	3640	86	78	77	63	71	67	69	8
US Army Aberdeen Proving Ground	205	82	77	73	67	62	67	62	27
Aberdeen Proving Ground Military Reservation	445	89	78	69	66	57	66	64	22
Camp Bullis	234	100	100	100	48	60	55	48	0
Edgewood Arsenal	40	70	70	70	70	70	70	70	20
New Cumberland General Depot (US Military R	130	88	88	78	54	66	54	66	8
Milan Arsenal And Wildlife Management Area	234	97	84	84	91	74	12	59	0
Fort Wolters	25	100	100	100	36	52	52	52	0
Fort Lewis Military Reservation	3089	61	61	64	54	60	56	60	40
Charles Melvin Price Support Center	8	100	100	100	100	25	0	25	0
Fort Devens (Closed)	140	66	66	66	50	66	66	66	0
Radford Army Ammunition Plant	240	90	87	97	70	27	27	27	19
Camp Swift N. G. Facility	650	100	100	100	37	31	24	29	8
Yuma Proving Ground	6052	84	74	81	15	73	42	52	1
Fort Rucker Military Reservation	702	74	74	74	74	48	43	28	0

Legend:
Percent Habit Unchanged By Climate Change
80-100% unchanged
50-80% unchanged
0-50% unchanged

		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	Size (0.02 x 0.02) degree cells	PCM B1 2050	PCM B1 2080	PCM A1 2050	PCM A1 2080	HAD B1 2050	HAD B1 2080	HAD A1 2050	HAD A1 2080
Fort Benjamin Harrison (Closed)	35	100	100	100	100	0	0	0	0
Los Alamitos Armed Forces Reserve Center	8	100	100	100	100	0	0	0	0
Sacramento Army Depot (Closed)	4	50	50	100	50	50	50	50	0
Fort Carson Military Reservation	30777	62	57	57	26	57	55	71	11
Rock Island Arsenal	5	100	40	40	0	0	100	100	0
Kansas Army Ammunition Plant	44	100	100	100	73	0	0	0	0
Fort McClellan Military Reservation (Closed)	242	93	85	93	37	30	7	21	0
Fort A. P. Hill Military Reservation	728	65	48	89	72	33	23	33	0
Navajo Army Depot (Closed)	221	69	64	67	20	44	34	43	16
Camp Atterbury Military Reservation	198	58	58	60	57	57	34	32	0
Redstone Arsenal	273	96	44	100	38	27	23	23	0
Fort Leonard Wood Military Reservation	756	100	100	100	12	15	0	7	0
White Sands Missile Range	13522	52	51	45	29	46	47	40	24
Camp Joseph T. Robinson	288	82	74	72	24	24	24	24	6
Red River Army Depot	242	59	51	51	51	54	23	31	0
Fort Polk Military Reservation	3450	94	93	90	18	10	4	7	0
Fort Wingate Depot Activity (Closed)	144	83	77	77	0	49	15	14	0

Legend:
Percent Habit Unchanged By Climate Change
80-100% unchanged
50-80% unchanged
0-50% unchanged

		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	Size (0.02 x 0.02) degree cells	PCM B1 2050	PCM B1 2080	PCM A1 2050	PCM A1 2080	HAD B1 2050	HAD B1 2080	HAD A1 2050	HAD A1 2080
Fort Bragg Military Reservation	1392	75	52	32	45	31	50	30	1
Lake City Army Ammunition Plant	18	100	100	100	6	6	0	0	0
Camp Johnson	9	44	44	44	44	44	22	44	22
Fort Leavenworth Military Reservation	63	87	100	100	0	16	0	0	0
Fort Hood	4321	72	72	73	22	22	21	21	0
Fort Gillem Heliport	15	100	100	100	0	0	0	0	0
Fort McPherson	4	100	100	100	0	0	0	0	0
Fort Monmouth Military Reservation	8	100	100	100	0	0	0	0	0
Longhorn Ordnance Army Ammo Plant	42	100	100	100	0	0	0	0	0
Fort Benning Military Reservation	1599	78	48	81	38	30	11	14	0
Mount Baker Helicopter Training Area	8017	42	42	39	34	40	36	36	25
Buckley Air National Guard AF Base	30	30	30	30	0	100	50	50	0
US Army Ammunition Depot	169	98	89	100	2	0	0	0	0
Military Ocean Terminal Sunny Point	150	100	100	80	0	0	0	0	0
West Point US Military Academy	121	61	56	68	23	50	10	10	0
Fort Gordon	792	78	64	80	12	19	13	13	0
Fort Campbell	925	96	74	82	4	19	0	1	0

Legend:
Percent Habit Unchanged By Climate Change
80-100% unchanged
50-80% unchanged
0-50% unchanged

		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	Size (0.02 x 0.02) degree cells	PCM B1 2050	PCM B1 2080	PCM A1 2050	PCM A1 2080	HAD B1 2050	HAD B1 2080	HAD A1 2050	HAD A1 2080
Fort Sill Military Reservation	900	42	38	38	38	38	38	38	0
Pine Bluff Arsenal	288	89	83	87	3	0	0	0	0
Fort Bliss McGregor Range	11190	35	31	29	35	43	44	23	12
Sunflower Army Ammunition Plant	35	83	83	83	0	0	0	0	0
Anniston Army Depot	90	70	53	70	20	11	11	11	0
Umatilla Chemical Depot (Closed)	88	59	55	27	23	24	20	24	0
Warrenton Training Center Military Reservatio	130	47	25	64	18	31	18	22	0
Fort Lee Military Reservation	66	36	50	50	27	50	0	0	0
Belle Mead General Depot	8	50	50	50	50	0	0	0	0
Fort Knox	2311	39	39	40	22	25	12	16	0
Iowa Army Ammunition Plant	170	72	55	36	7	7	7	7	0
Fort Jackson	527	64	13	13	54	13	13	13	0
Fort Ritchie Military Reservation (Closed)	2011	27	25	27	19	19	23	22	8
Hunter-Liggett Military Reservation	11581	23	22	23	22	21	19	21	11
Lexington-Blue Grass Army Depot (Closed)	1915	37	36	37	4	4	7	5	0
Fort Dix Military Reservation	1529	20	20	20	14	19	14	13	1
Fort Drum	3877	24	21	24	7	17	10	11	3

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		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	Size (0.02 x 0.02) degree cells	PCM B1 2050	PCM B1 2080	PCM A1 2050	PCM A1 2080	HAD B1 2050	HAD B1 2080	HAD A1 2050	HAD A1 2080
Fort Huachuca	6280	14	15	18	10	17	13	10	4
Army Chemical Center	4	0	0	100	0	0	0	0	0
Blossom Point Field Test Facility	15	100	0	0	0	0	0	0	0
Greencastle Military Reservation	9	0	0	0	0	0	100	0	0
Indiana Arsenal Army Ammuniton Plant (Closed)	1439	15	15	15	10	10	9	11	0
Yakima Firing Center	12237	11	11	11	10	10	8	10	0
Ravenna Arsenal	1381	13	13	13	12	6	2	6	6
Tooele Army Depot	4069	9	9	7	6	6	4	4	3
Fort Bliss	8206	7	5	3	5	9	7	5	5
Seneca Army Depot (Scheduled to close)	1281	6	6	6	4	6	4	4	3
Fort Ord Military Reservation (Closed)	5071	6	5	5	6	6	5	7	1
Fort Eustis Military Reservation	1268	5	5	5	5	6	4	7	3
Fort Ethan Allen Military Reservation	1273	6	6	6	5	6	6	4	0
Fort Chaffee (Closed)	8316	7	7	7	4	5	1	3	0
Camp MacKall Military Reservation	66	12	9	0	0	0	12	0	0
Picatinny Arsenal	1305	6	5	6	3	5	0	0	0
Fort Indiantown Gap Military Reservation (Clo	1513	8	5	5	1	1	1	2	1

Legend:
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		PCM Model				Hadley Model			
		Low Emissions		High Emissions		Low Emissions		High Emissions	
Installation	Size (0.02 x 0.02) degree cells	PCM B1 2050	PCM B1 2080	PCM A1 2050	PCM A1 2080	HAD B1 2050	HAD B1 2080	HAD A1 2050	HAD A1 2080
Letterkenny Army Depot	1321	5	4	5	2	2	3	2	0
Pueblo Chemical Depot (Closed)	5344	2	2	2	2	2	2	3	0
Sierra Army Depot	7107	3	2	3	2	3	2	2	0
Camp Bonneville Military Reservation (Closed)	1226	2	2	2	2	2	2	3	0
Craney Island Disposal Area	1222	2	2	2	2	2	2	2	0
Fort Story Military Reservation	1220	1	1	1	1	1	1	1	0
Utah Launch Complex White Sands Missle	5301	2	1	3	1	1	1	1	0
Camp Parks Military Reservation	1221	2	0	0	0	0	0	0	0
Defense Depot Ogden (Closed)	1208	0	0	0	0	0	0	0	0
Fort Sheridan (Closed)	1202	0	0	0	1	0	0	0	0
Oakland Army Base (Closed)	3606	0	0	0	0	0	0	0	0
Presidio of Monterey	3609	0	0	0	0	0	0	0	0
Camden Test Annex	3	0	0	0	0	0	0	0	0
Fort Ritchie Raven Rock Site	9	0	0	0	0	0	0	0	0
Vint Hill Farms Station Military Reservation	4	0	0	0	0	0	0	0	0

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14. ABSTRACT
Military installation training lands must be managed to support species at risk as well as to be effective training environments for soldiers. Forecasts from various global climate change models suggest that the habitats associated with some military training installations will face pressures that induce biome-shifts, invasive species, loss of habitat, and changes in training opportunities. This study combined worldwide habitat forecast data with a current habitat map to identify major installations that appear to be most and least at-risk for habitat change.

15. SUBJECT TERMS
ecosystem management, climate change, habitat, military training, modeling

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