Mapping the Western Pond Turtle (Actinemys marmorata) and Painted Turtle (Chrysemys picta) in Western North America

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MAPPING THE WESTERN POND TURTLE (*ACTINEMYS MARMORATA*) AND PAINTED TURTLE (*CHRYSEMYS PICTA*) IN WESTERN NORTH AMERICA

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ABSTRACT—We georeferenced Western Pond Turtle (*Actinemys marmorata*) and Painted Turtle (*Chrysemys picta*) locality records in western North America, compiling diverse institutional data sets, including data from 9 US states and Canadian provinces. For the entire range of the Western Pond Turtle and the western range of the Painted Turtle, we assessed counts of distinct locations from historical data, and analyzed distribution patterns temporally and spatially. Western Pond Turtle observation records were compiled from year 1850 to 2011, and Painted Turtle records were compiled from 1805 to 2011. For the Western Pond Turtle, 2935 locations were compiled rangewide; using a 500-m buffer criterion to aggregate adjacent coordinates to assess distinct localities, we consolidated these to 2111 discrete sites. We compiled 2953 locations for the Painted Turtle, which consolidated to 1219 discrete sites in the United States using the same 500-m criterion. The mapped data illustrate spatiotemporal patterns, which can be used to advance new efforts toward turtle management in northwestern North America.

Key words: Chelonia, distribution, historical data, mapping

In the last 2 decades, a persistent call has been made for inventory and monitoring of declining species, especially herpetofauna (Heyer and others 1994; Olson and others 1997; Olson 2009; Bury and others 2012a; Graeter and others 2013), because species conservation efforts rely on distribution and abundance information for prioritization of management actions. In many cases, historically collected data can provide important contexts for updated status assessments (e.g., via revisits to historic sites: Bradford 1994; Lips and others 2004), and may be used for range determination, identification of geographic areas or populations vulnerable to losses, or developing hypotheses of potential threats linked to declines. Additionally, knowledge of historical locations can be used to develop landscape-scale habitat models (for example, Suzuki and others 2008), and to design strategic surveys for updated species occupancy assessments (Olson and others 2007). Unfortunately, rangewide historical baseline locality data are not readily available for many US herpetofauna. With suspected recent and potentially sudden losses in native US turtles due to over-exploitation and habitat-related disturbances (Kiester and Olson 2011), an assessment of their known distributions patterns is warranted.

Of the 328 recognized turtle species living today worldwide, 47.6% are identified as Threatened, with 27.4% of these listed as Critically Endangered or Endangered (Turtle Taxonomy Working Group [TTWG] 2010). This threat level exceeds that of all other higher vertebrate groups, with amphibians at 41%, mammals at 25%, and birds at 13% (Hoffman and others 2010). In addition, almost 20% of the recognized turtle species in the world occur in the United States, a world hotspot for turtle species diversity (Kiester and Olson 2011). The loss of turtle diversity is primarily the result of habitat loss and over-exploitation for food, medicine, and the pet trade (Kiester and Olson

2011). World turtle conservation efforts are increasing to address these issues (TTWG 2010). In 2011, Partners in Amphibian and Reptile Conservation (PARC), in collaboration with the International Union for the Conservation of Nature (IUCN) Freshwater Turtle Specialist Group, developed a list of US turtle species for which better distribution information was needed to aid in the assessment of their conservation status. This list included both rare and common species, both of which are conservation priorities (Kiester and Olson 2011), with the list targeting species that need more attention because distributions may be changing due to habitat degradation or over-exploitation. These species included: Diamondback Terrapin (*Malaclemys terrapin*); Red-eared Slider (*Trachemys scripta elegans*); Desert Tortoise (*Gopherus agassizii*); Texas Tortoise (*Gopherus berlandieri*); Gopher Tortoise (*Gopherus polyphemus*); Snapping Turtle (*Chelydra serpentina*); Eastern Box Turtle (*Terrapene carolina;* especially *T. c. carolina*); Ornate Box Turtle (*Terrapene ornata*); and Painted Turtle (*Chrysemys picta*). To contribute to this larger effort, we conducted site compilation for species occurring in Oregon, the Western Painted Turtle (*C. picta bellii* Gray, 1831) and the Western Pond Turtle (*Actinemys marmorata* Baird and Girard, 1852; alternative genus assignments to *Clemmys* and *Emys* are summarized in Crother 2008; Bury and others 2012b). We expanded our perspective for these 2 species beyond Oregon, and compiled known observations in western North America, from Baja California, Mexico, to British Columbia, Canada, and from the Pacific Ocean to Montana and Wyoming.

The status of both Western Pond Turtles and Painted Turtles is of concern in western North America. The Western Pond Turtle is ranked as globally vulnerable (G3G4) by NatureServe (www.natureserve.org; accessed 2 August 2012), and by state and province it is listed as: imperiled (S2) in Oregon (Oregon Biodiversity Information Center 2010); endangered (S1) in Washington (http://wdfw.wa.gov/conservation/endangered; accessed March 2012); vulnerable (S3) in California (http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/spanimals.pdf; accessed July 2012); vulnerable (S3) in Nevada; and is extirpated in Canada (COSEWIC 2012). With increased urbanization, the Western Pond Turtle faces increased disturbances from humans and pets, and deaths from road traffic (Spinks and others 2003; Rosenberg and others 2009; Germano and others 2012). Bury and others (2012b) acknowledged that although habitat loss, degradation, and fragmentation, introduced species (see also Germano and others 2012), and pollution negatively affect Western Pond Turtles, artificial habitats have been created that may benefit the species. Although Holland (1994) considered declines to be occurring across a sobering 80% of their range, he acknowledged a lack of surveys in many areas and a need for monitoring. Endorsing the need for baseline monitoring, Germano and others (2012) reported on the illegal trade of Western Pond Turtles, but they considered the consequences to be unknown given broad variability in abundance levels across the species range. However, rangewide, both abundance patterns and distribution of occurrences are not well compiled.

The Painted Turtle is similarly listed as a species of concern in some areas of the northwest, although it is ranked as globally widespread and secure (G5; www.natureserve.org; accessed 2 August 2012). The western form is listed as: imperiled (S2) in Oregon where it is a critically sensitive species (http://www.dfwstate.or.us/wildlife/diversity/species/docs/SSL_by_category.pdf; accessed July 2012); apparently secure (S4S5) in Washington; apparently secure (S4) in Idaho, Montana and Wyoming; and vulnerable (S3) in British Columbia, where it is considered endangered in some areas and a species of concern in other areas (British Columbia Frogwatch Program 2011). The mix of status rankings among jurisdictions suggests that knowledge of population abundances or threats may vary geographically. The Painted Turtle occurs across North America, and the western form faces threats and disturbances to their populations similar to the Western Pond Turtle (Gervais and others 2009). Here again, a rangewide compilation of abundance patterns or distribution of occurrences is lacking for this species.

The goal of our study was to consolidate existing institutional locality records of the Western Pond Turtle across its range into a comprehensive database, and initiate a similar effort for the Painted Turtle in western North America. Although each US state and Canadian province manages the fauna within their jurisdiction and hence maintains locality data for sensitive species including turtles, a range-wide compilation of turtle occurrences from these corportate databases has not been conducted. Such an aggregation of data may provide insight to understand range-scale distributions patterns and inform downscaled status assessments within individual state or provincial jurisdictions. Through a continental campaign to compile extant turtle distributions initiated in 2011 (http://parcplace.org/news-a-events/year-of-the-turtle.html; accessed 16 September 2013), new data were compiled in addition to retrieval of existing institutional or personal site data. We used our newly compiled database to assess broad spatial and temporal patterns of turtle distribution. We provide an accounting of data distribution by date of first and most-recent record, along with an analysis of discrete sites by broad land ownership categories in the US. This range-wide compilation of existing information on the known locations of the Western Pond Turtle and our northwest compilation of Western Painted Turtle locations may inform cross-jurisdictional status assessments, a more strategic approach to inventory, monitoring, and conservation of these species, and downscaled research into abundance patterns or potential threats.

METHODS

Locality data records were compiled from institutions or agencies and several individuals. Databases were retrieved from 9 organizations: Bureau of Land Management (BLM), California Department of Fish and Game (CNDDB), US Forest Service (FS), University of California at Berkeley-Museum of Vertebrate Zoology, Montana Natural Heritage Program, Oregon Biodiversity Information Center (ORBIC), Washington Department of Fish and Wildlife (WDFW), Wyoming Natural Diversity Database (WNDD), and British Columbia Ministry of the Environment, Canada. Data from US states and British Columbia were especially important for our compilation because they have independent processes in place to compile locality records within their jurisdictions (such as, from collecting or scientific permits), and most have conducted syntheses, studies, outreach, and literature searches to gain more complete records due to the species' sensitive status within their boundaries, including assessments for threatened-and-endangered species listing proposals. Locality data contracts were required for databases from CNDDB, WDWS, ORBIC, WNDD, and British Columbia. Although these contracts restrict access to our comprehensive database, access could be gained if external entities were to attain approval from these 5 institutions. Individual site records were received from herpetologists and nature enthusiasts through PARC, and from regional species experts. The 2011 Year of the Turtle campaign generated a community movement that created public awareness to promote turtle sightings (http://parcplace.org/news-a-events/year-of-the-turtle.html; accessed 16 September 2013); some locality records resulted from this effort. We acknowledge that our data compilation efforts were restricted to corporate databases and hence our database is incomplete, especially relative to individually maintained datasets, but in particular, our information from Idaho is deficient because the state does not maintain Painted Turtle locality data.

A comprehensive data file was generated that included location, state or province, observation dates, and data file source using GIS ArcMap Version 9.3.1. Many data sets shared locality points. For our purpose, only 1 data record was needed to represent a location. Records that had the same coordinates were identified and consolidated to 1 location. We produced maps as a pictoral representation of these locality observations over the years to catalog the prevailing knowledge of these turtles' distributions. Because some data sources required contractual agreements wherein we agreed not to release sensitive locality data, our maps are produced at a coarse spatial resolution.

Data quality control and quality assurance were limited to procedures that had been put in place by the original data sources; hence, the data may be prone to errors. In particular, the original surveys likely represent a mix of designed studies and haphazard efforts, the qualifications of observers reporting the original localities are often unknown, and the potential for species misidentification was not addressed during the original surveys or data uploads to the various institutional databases. Hence observer bias and data errors could have been translated into our comprehensive compilation. We noted that data records were rarely accompanied by a voucher specimen or photograph, elevating uncertainty concerns for accurate species identifications. Confusion between the Western Painted Turtle and the Red-eared Slider (*Trachemys scripta elegans*) may be one such error in the original data files, although we suspect the scope of this error to be limited. Despite the limited data quality assurance, the value of current composite records should not be dismissed, as they represent an historical accounting of species knowledge, and can provide the basis for future work.

We examined the dates of site records to assess both the first and the most-recent observation per location. First observations per location are of potential interest for understanding the historical distribution of species, as well as an historic accounting of when people took interest in conducting turtle distribution surveys. Recency of turtle observations may be relevant to assessments of locations of extant populations. We also assessed numbers of unique or ''discrete'' sites, a metric that may be used during status assessments within jurisdictions or development of conservation priorities (for example, Clayton and Olson 2007; Olson and Davis 2007; Olson and others 2009; http://www.natureserve.org/explorer/ranking.htm#assessment; accessed 16 September 2013). Discrete sites have been defined by examining distances between locality coordinates, and consolidating localities within close proximity to each other into a polygon that is a larger ''discrete site.'' Proximity criteria used to define unique sites consider the likelihood of animals interacting with each other, known home range sizes of individuals (inclusive of breeding, overwintering and foraging sites), as well as the dispersal distances of animals. To define a discrete site for our turtle data, we chose a 500-m criterion. The distance of 500 m was used based on known movements and dispersal distances of both Western Pond Turtles and Painted Turtles (reviewed in: Rosenberg and others 2009; Gervais and others 2009; see also Bury and others 2012c). Although individuals of both turtle species can move longer distances, and are noted to move further in river systems in particular, the 500-m distance was inclusive of many movement reports, especially upland nesting forays from aquatic habitats, and was considered useful as an initial distance to segregate potentially overlapping site records for a local area. Importantly, we do not consider 500-m to be a distance to definitively distinguish turtle sub-populations. All site records within 500 m (straight-line distance) of an adjacent record were consolidated to represent 1 discrete site. The ArcMap tools ''Point Distance'' and ''Identity'' were utilized for this analysis.

In our west-wide assessment, US federal lands represented a significant portion of the landscape within these turtles' ranges. Counts per US federal land ownership were compiled because they may be useful to prioritize species management efforts on public lands that cross state boundaries, and where species conservation is a priority. A downscaled exercise of this sort might include local land owneships, but was not attempted here. GIS coverages differed for Canada, precluding a comparable analysis of Painted Turtle discrete sites and land ownership patterns. We computed area of species ranges by calculating the minimum convex polygon around discrete sites, and for the Painted Turtle, we included data records for British Columbia to provide an estimate of the northwestern range.

RESULTS

For the Western Pond Turtle, 2935 locality records were compiled that spanned the entire range of the Western Pond Turtle from Mexico (14 records) to Canada (1 record, extirpated). For the Painted Turtle, 2953 locality records were compiled in the northwest. Using the 500-m criterion to consolidate adjacent locations, 2111 discrete sites of Western Pond Turtles resulted, inclusive of sites in Canada and Mexico (Table 1). Most discrete sites were in California (56%; Table 1), and in the US, most were on non-federal land (71%; Table 2). For Painted Turtles, the same 500-m buffer applied to US locations only yielded 1201 discrete sites, with the majority occurring in Montana (70%, Table 1) and on non-federal land (63%, Table 3). Most locality records were isolated (i.e., >500-m apart), and did not get aggregated during the discrete sites analysis (Tables 2 and 3), suggesting that only a subset of sites may have occurred in spatially extensive habitats that would be subject to this clustering process.

TABLE 1. Rangewide discrete site counts for the Western Pond Turtle (*Actinemys marmorata*), and discrete site counts for the Painted Turtle (*Chrysemys picta*) within the northwestern US states. Total counts of Painted Turtle data records are presented for British Columbia, Canada. Discrete sites were compiled by adjoining data records with spatial coordinates that were within 500 m of each other in order to reduce duplication of locations.

State/ Province	No. Western Pond Turtle sites	No. Painted Turtle sites
Baja California, Mexico	14	0
California, US	1191	0
Nevada, US	16	0
Oregon, US	859	120
Washington, US	30	219
British Columbia, Canada	1	268
Montana, US	0	841
Wyoming, US	0	21
Total	2111 (2096 US sites)	1469 (1201 US sites)

The geographic range of the Western Pond Turtle encompassed 646,759 km^2, which might be considered a maximum range since it includes extirpated or potentially invalid native sites (RB Bury, pers. comm.) in British Columbia, Oregon, and Nevada (Fig. 1). The Painted Turtle range within the western states that we examined, plus British Columbia, was 1,285,671 km^2.

The range of observation dates for Western Pond Turtle records spanned years 1850 to 2011. The earliest record is from 1 January 1850, reported by George Suckley in the Washington state database. The majority of 1st-observation efforts took place in the 1990s (Table 4). In addition, our data retrieval documented that only 91 occupied sites were revisited in the 2000s. The Painted Turtle in western North America had a broader range of observation dates, from 1805 to 2011. The 1st record in the Montana state database was for 25 June 1805, when Meriwether Lewis reported observing ''a number of water terripens'' (Lewis and Clark 1904). An editor's footnote from the published edition of the journals states: ''The water-terrapin is doubtless *Emys elegans*''. Taxonomy, however, has come a long way since 1904, as has the delineation of ranges of North American turtles. *Emys elegans* would currently be *Trachemys scripta elegans*, the Red-eared Slider, the native range of which does not include Montana. However, this species is easily mistaken for the Painted Turtle, *Chrysemys* [once *Emys*] *picta*, of which the subspecies *C. p. bellii* is native to Montana. The record in the Montana Natural History Database for *C. p. bellii* for an observation dated 25 June 1805 should thus be credited to Meriwether Lewis. The majority of 1st observation efforts for the Painted Turtle took place in the 2000s (Table 4), and only 19 sites were recorded as being revisited for this turtle.

DISCUSSION

We present range-wide locality maps for the Western Pond Turtle and western North America locality maps for the Painted Turtle that were assembled largely from 9 institutions and political jurisdictions (Figs. 1–4). Our maps document efforts to identify 3580 ''discrete sites'' of turtles over the timeframe of 161 y. These are composite maps of past observations,

TABLE 2. United States federal land ownerships of Western Pond Turtle (*Actinemys marmorata*) discrete sites based on a 500-m buffer distance. ''Unique'' column is the number of sites that had no other sites within a 500-m radius. The ''Cluster'' column is the number of discrete sites generated from clusters of sites within 500-m of each other.

Land ownership	Unique	Clusters	Total (%)
Bureau of Land Management	89	26	115 (5.5)
Bureau of Reclamation	14	0	14 (0.7)
Department of Defense	44	7	51 (2.4)
Forest Service	301	65	366 (17.5)
US Fish and Wildlife Service	32	1	33 (1.6)
National Park Service	33	2	35 (1.7)
Non-federal land	1341	141	1482 (70.7)
Total	1854	242	2096

TABLE 3. United States federal land ownerships of Painted Turtle (*Chrysemys picta*) discrete sites based on a 500-m buffer distance. ''Unique'' column is the number of sites that had no other site within a 500-m radius. The ''Cluster'' column is the number of discrete sites generated from clusters of sites within 500-m of each other.

Land ownership	Unique	Clusters	Total (%)
Bureau of Land Management	139	40	179 (14.9)
Bureau of Reclamation	3	1	4 (0.3)
Department of Defense	10	3	13 (1.1)
Forest Service	131	49	180 (15.0)
U.S Fish and Wildlife Service	49	10	59 (4.9)
National Park Service	9	2	11 (0.9)
Other	1	1	2 (0.2)
Non-Federal Land	641	112	753 (62.7)
Total	983	218	1201

and are not reflective of current locations or extant populations. Data on ''no detections'' of turtles during surveys were not available for collation, hence, gaps in distribution portrayed by our maps do not necessarily depict 'absence' of turtles, but may simply represent observer bias in areas surveyed. Our breakdown of data by date, discrete sites, and federal land ownership is an historical accounting for turtle surveys in the area and can be used for development of future inventory and monitoring programs, and prioritization of conservation efforts. Our maps are available upon request; our database is available if necessary permissions are gained from 5 source institutions which required contracts to have access to sensitive species data. Future uses of our comprehensive data should consider the variety of data sources and their associated data quality concerns.

In particular, our data compilation across political jurisdictions is insightful for multi-scale science and management program development, inclusive of status assessments and development of restoration plans. Holland (1993) conducted an Oregon range assessment for Western Pond Turtle occurrences, and reported that the species occurred at 83 of 313 (26.5%) sites he surveyed. Although his result suggested an alarming decline of this turtle in Oregon, using our data with 891 discrete sites in Oregon, a more robust randomly designed subsample with geographic and habitat stratification could provide inference to the broader landscape or sampled population of sites, to contribute to a contemporary status assessment.

TABLE 4. Decade of 1st- and most-recent observation date of the Western Pond Turtle (*Actinemys marmorata*) and the Painted Turtle (*Chrysemys picta*) for all sites in northwestern North America. Most-recent observation = no. sites/decade for the subset of locations for which at least 2 observation dates were compiled. Total for each column is 2935.

	Western Pond Turtle		Painted Turtle	
Decade	1st observation	Most-recent observation	1st observation	Most-recent observation
Unknown	299	272	200	200
<1900s	50	50	38	38
1900s	4	4	16	16
1910s	23	23	5	5
1920s	17	16	14	14
1930s	33	33	50	48
1940s	23	19	20	20
1950s	26	23	23	23
1960s	143	140	29	28
1970s	80	66	98	82
1980s	253	222	185	197
1990s	1066	1058	716	716
2000s	897	988	1402	1409
2010s	21	21	157	157

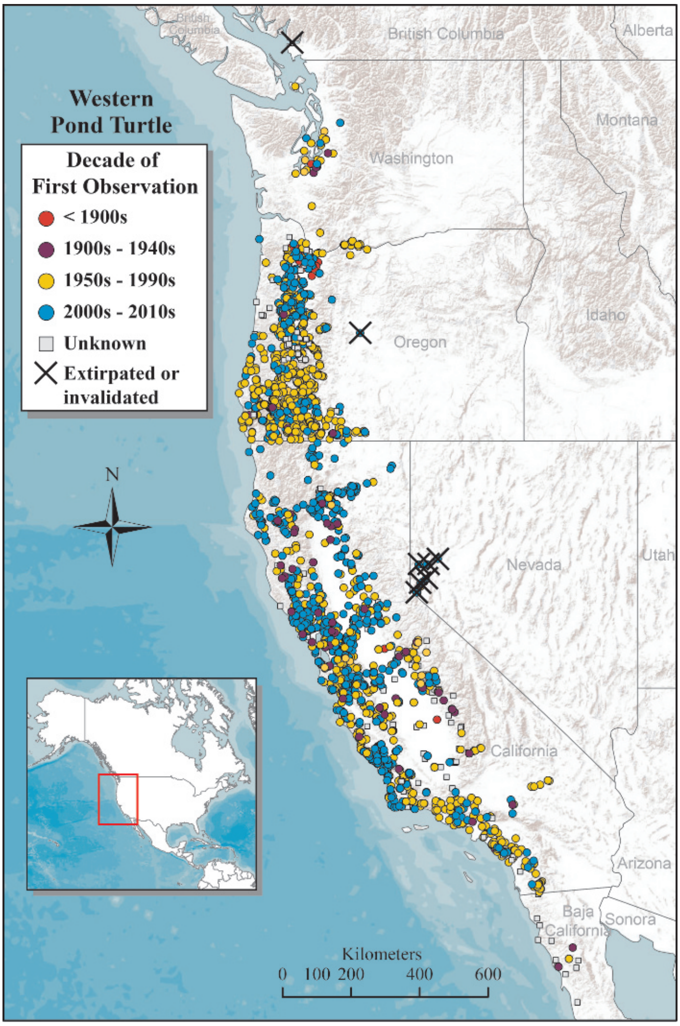

FIGURE 1. Map of Western Pond Turtle (*Actinemys marmorata*) locality records from Mexico to Canada displayed by decade of 1st observation, showing historical accumulation of distribution knowledge with time. X = extirpated sites, or potentially invalid native sites where an introduction is suspected (from RB Bury, pers. comm.). *n* = 2935 locations.

Also, Holland's site count was based on turtle observations and did not infer that breeding populations of turtles were extant at those 83 sites; in addition to ''presence'' data, additional field data would be needed to ascertain population metrics in a newly designed study from our data set as well. Western Pond Turtles may live >40 y (Bury and Germano 2008), and although the lifespan of the Painted Turtle is not as well documented, Painted Turtles in the wild may live 50 y or longer (COSEWIC 2006). The presence of adult turtles can be a false indication of healthy breeding populations if recruitment of young is not occurring yet adults are able to survive. Although this concern was allayed by a recent report that young Western Pond Turtles were being found across the range of the species (Bury and others 2010), a quantitative assessment of population demography during a study with broad geographic inference would substantiate the distribution of extant breeding populations. Survey approaches to assess Western Pond Turtle populations were recently summarized

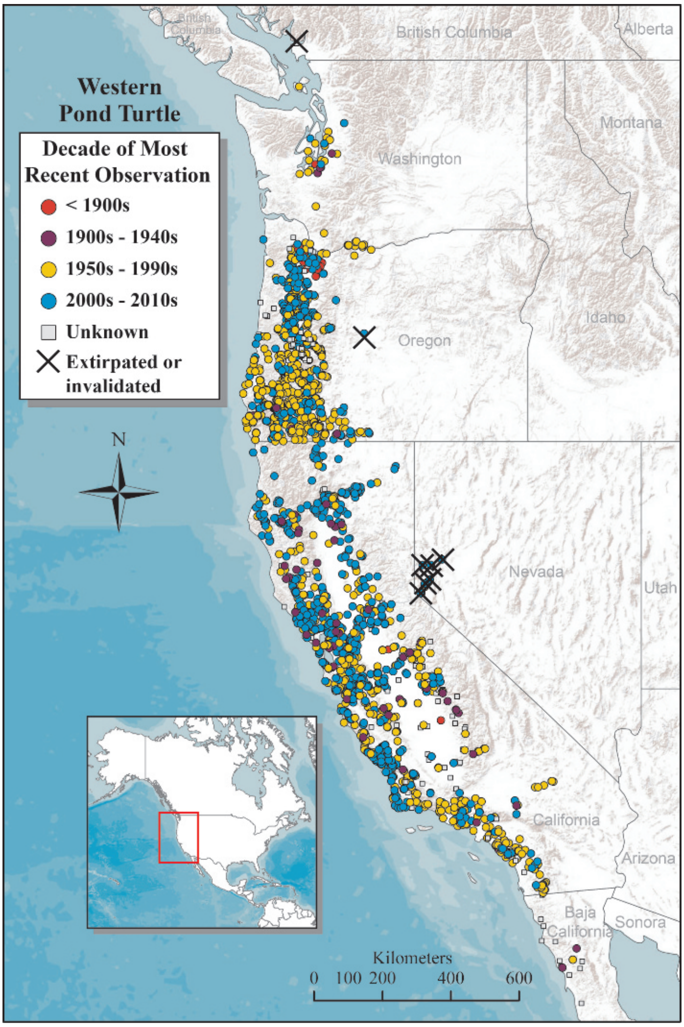

FIGURE 2. Map of Western Pond Turtle (*Actinemys marmorata*) locality records from Mexico to Canada displayed by decade of most-recent observation, showing potentially extant occurrences. X = extirpated, or potentially invalid native sites where an introduction is suspected (from RB Bury, pers. comm.). n = 2935 locations.

(Bury and others 2012a), and Graeter and others (2013) provide additional methods considerations, including recommendations for photographic vouchers.

From our results, sites observed before the 1970s or with an unknown observation date may be identified as a priority for reassessment. Such sites encompass 20% of all points compiled before our discrete site analysis for Western Pond Turtles, and 13% for Painted Turtles in our study area (Table 4). Also, from the data we compiled, only a small proportion of sites were documented to have had revisits over the years (Table 4). Sites without revisits could be prioritized for new surveys as well. There are noticeable gaps in the range map that could be related to fragmentation of suitable habitat or population connectivity, or to lack of data. These areas might warrant closer examination. For both species, more data compilation could be conducted as additional data sources are identified, but for Painted Turtles in particular, more compilation is needed to fully represent their distribution across North America.

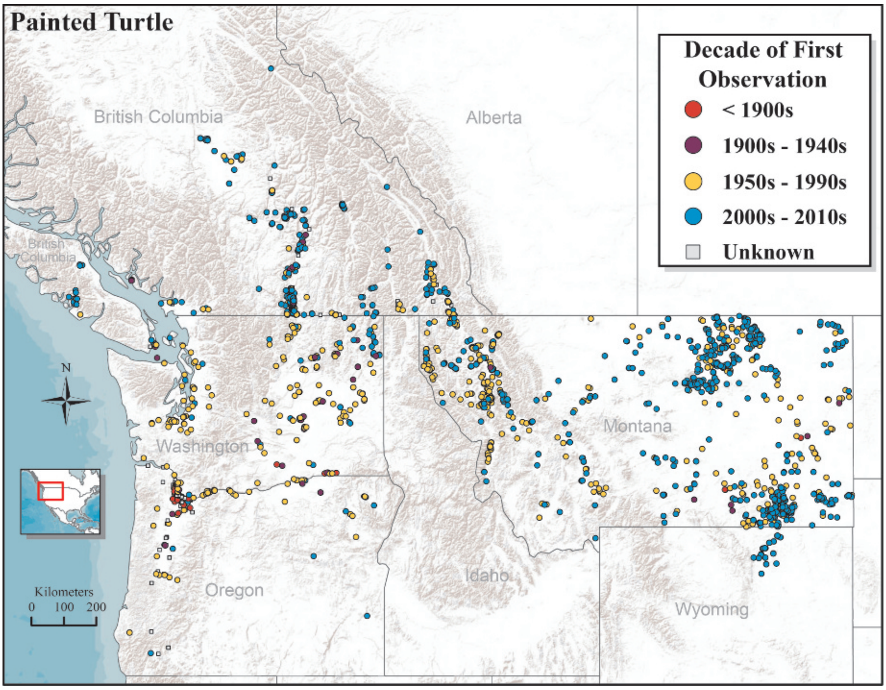

FIGURE 3. Map of Painted Turtle (*Chrysemys picta*) locality records from Canada and northwest United States displayed by decade of 1st observation, showing historical accumulation of distribution knowledge with time. $n = 2953$ locations.

Our data also could be used to conduct landscape-scale habitat association modeling, which could subsequently be validated with a designed survey of modeled suitable habitats. Inclusion of climate metrics in range-wide habitat models could assess the importance of climate change scenarios for the future distributions of these species. Climate change is a contemporary concern for freshwater turtles worldwide (Kiester and Olson 2011).

Our discrete-sites analysis was conducted to consolidate multiple turtle observations over the years from the same local area. This type of spatial aggregation of data may provide insights for species' historical ranges and future conservation planning. For species status assessments, organizations such as NatureServe consider number of occurrences broken out by both locations and ''discrete areas'' in their calculations of rankings (http://www.natureserve.org/explorer/ranking.htm#assessment; accessed 16 September 2013). Also, US federal conservation assessments and strategies for Pacific Northwest salamanders have conducted such merging of neighboring site locations when occupancy of contiguous habitat was implicated, and this aggregation was then used to inform land management considerations and decisions regarding site-scale to broader-scale prioritization of actions (for example, Clayton and Olson 2007; Olson and Davis 2007; Olson and others 2009). Clusters of sites (Tables 2 and 3), might be used to identify areas with larger populations, which may be useful for conservation planning. Site clusters were used to identify priority sites for conservation in the Siskiyou Mountains Salamander, *Plethodon stormi*, for example (Olson and others 2009). Furthermore, our tally of discrete sites sorted by US federal land ownership can inform land managers of the potential protection offered to turtle locations from known species-prioritization practices among land ownerships. From the broad distribution of turtle sites in the West, the need to examine the mix of land ownerships is apparent to enable partnership development in order to design landscapes to maintain contiguous populations. Although, due to human development, this is unlikely to be feasible in many US-west locations now, design of connected populations may be a priority

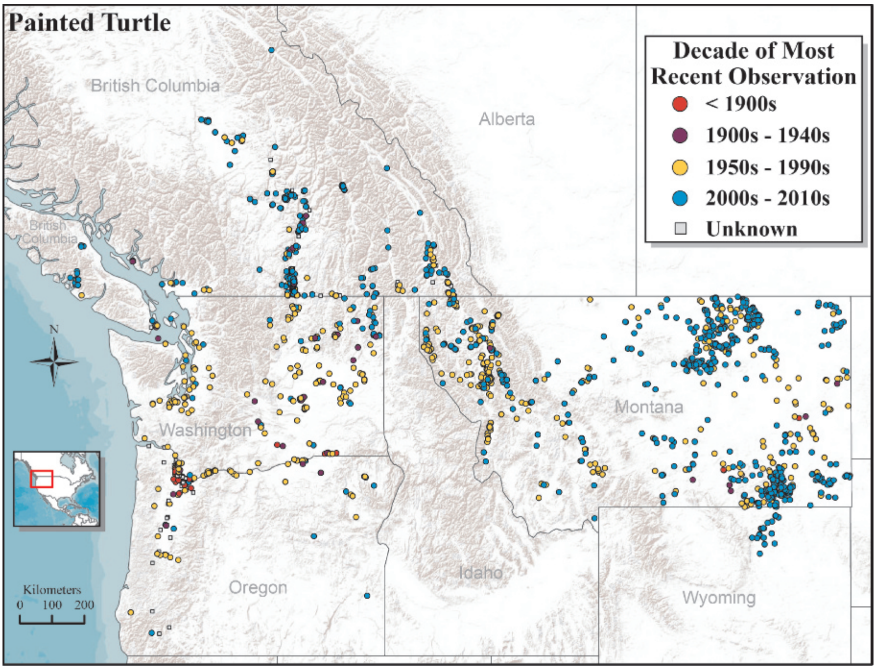

FIGURE 4. Map of comprehensively compiled localities of the Painted Turtle (*Chrysemys picta*) from Canada and northwest United States displayed by decade of most-recent observation, showing potentially extant occurrences. $n = 2953$ locations.

conservation direction in many sub-regions of the ranges of these 2 turtle species. We assessed turtle distributions on federal land ownerships because of the west-wide extent of both those holdings and our data compilation, but other land ownerships could be analyzed as well, especially at local to sub-regional scales.

It was readily apparent from our data compilation that development of a single overarching atlas system for North American herpetofauna is past due, but would be difficult to assemble and oversee. Several information portals have emerged over the past few decades, and relative to species data, there is a wide spectrum of information being collected, data formats and standards, and data aggregation and quality assurance procedures. We found that merging the few sources that we addressed for these 2 turtle species was no simple task. Museums with voucher specimens have historically provided the 'gold standard' of data assurance, but recent data are being more readily compiled by organizations responsible for managing species in the wild. In this regard, state, federal, and provincial datasets are a mix of data types: some data may have associated photographic or genetic tissue vouchers, and data from larger projects may include metadata with survey protocols and documentation of field crew training or credentials. Data collected from agency wildlife biologists or by scientific collection permits may provide support for observer expertise (for example, observations by trained biologists who are less likely to make species identification errors). A trend is now emerging for encouragement of citizen-science surveys to harness the enthusiasm of the public to both reconnect people with nature and help document our local wildlife natural heritage. The 2011 Year of the Turtle campaign to update species locality data was 1 example of a broad effort to engage the public in turtle inventories. Many of these inventories were run by local nature centers, with oversight by wildlife experts. Data from these efforts and those of single private individuals, and sometimes unnamed observers, are archived by state and federal databases. Furthermore, ongoing discussions about the utility of free-sourced online animal atlases, to which anyone might contribute locality data by real-time data uploads, are gaining momentum. The global amphibian chytrid fungus mapping project is one such example of such an online species database to which anyone might contribute (www.Bd-maps.net; accessed 16 September 2013); it has already proven to be valuable in detecting occurrence patterns (Olson and others 2013). As online databases emerge, it would be useful for a two-step standardized data-certainty rating system to be developed. First, as a required database entry field, the reporter's self-evaluation of data integrity could be rated, and a photographic voucher could be uploaded (Graeter and others 2013). Second, a database manager could oversee data uploads to provide quality assurance assessments, and if feasible, obtain needed information from the observer. For our turtle sites compilation, such a certainty assessment would be useful to further evaluate localities in our database, and could be conducted in follow-up studies, or with efforts to expand the compilation.

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