

CITIZEN SCIENTIST TAGGING REVEALS DESTINATIONS OF MIGRATING MONARCH
BUTTERFLIES, *DANAUS PLEXIPPUS* (L.) FROM THE PACIFIC NORTHWESTDAVID G. JAMES^{*1}, TANYA S. JAMES¹, LORRAINE SEYMOUR¹, LINDA KAPPEN²
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ABSTRACT. The fall migration of Monarch butterflies (*Danaus plexippus*) in the Pacific Northwest (PNW) was studied in an unfunded citizen science project during 2012–16 by tagging 13778 reared and 875 wild Monarchs. More than a third of these Monarchs were reared by inmates of the Washington State Penitentiary (WSP) in Walla Walla, Washington. Sixty (0.41 %) tagged Monarchs were recovered from distances greater than 10 km (mean: 792.9 ± 48.0 km) with most found in California, SSW of release points. One WSP-reared Monarch was found 724 km to the SE in Utah. Monarchs tagged in Oregon flew SSE to California. No Idaho-tagged Monarchs were found in California but two were recovered at locations due south. No wild tagged Monarchs from Washington, Oregon or Idaho were recovered. Monarchs from Washington and Oregon were found during October–February at 24 coastal California overwintering sites spanning 515 km from Bolinas to Carpinteria. A single wild spring Monarch tagged in May in northern California was recovered 35 days later and 707 km ENE in Twin Falls, Idaho. This study provides compelling evidence that many Monarchs in southern and central parts of Washington and Oregon migrate south in the fall to overwintering sites along the California coast. It also provides some evidence for southerly and south-easterly vectoring of migrating Monarchs from eastern Washington and Idaho, indicating the possibility of migration to Arizona or Mexico overwintering sites. In addition to improving our understanding of Monarch migration in the PNW, this study also contributed to conservation by adding nearly 14000 butterflies to the population. The incredible involvement of incarcerated and non-incarcerated citizen scientists generated much community and media interest which in turn led to greater involvement by citizens. Increased awareness of Monarchs, their biology and conservation in the PNW has been an unexpected but important spin-off of this study.

Additional key words: overwintering sites, migration directions, conservation, incarcerated citizen scientists.

It has long been assumed that all Monarch butterflies, *Danaus plexippus* (L.), seen in the summer in the Pacific Northwest (PNW) (British Columbia, Washington, Idaho, Oregon) originate from California and return in the autumn to that state for overwintering (e.g. Urquhart 1960, Urquhart and Urquhart 1977, Brower 1995, Dingle et al. 2005, Stevens and Frey 2010). Pyle (2015) in a review on Monarchs in the PNW noted that this was an assumption based on good sense rather than an abundance of good scientific evidence. However, some limited data do exist showing movement of wild Monarchs from the PNW to California. Essentially, these comprise about a dozen records of tagged Monarchs flying from Boise, Idaho to the California coast in the 1970's, and a single individual from Roosevelt, Washington found on the California coast near Santa Cruz in 1997 (Pyle 2015). Tagged Monarchs used in Urquhart and Urquhart (1977) and by a Monarch enthusiast (Paul Cherubini, pers. comm.)

provided other records of migration to California but are not considered to be an accurate and reliable representation of what PNW Monarchs do because they involved Monarchs obtained in California and Ontario, shipped to the PNW for release. See Pyle (2015) for a detailed explanation why transferred Monarchs cannot be considered as surrogates for naturally occurring Monarchs in the location of release. Therefore, the data emanating from the transfer experiments of Urquhart and Urquhart (1977) were instrumental in building the potentially flawed canon that all PNW Monarchs migrate to and from California. Moreover, there are some data and observations suggesting that autumn PNW Monarchs may also migrate in directions other than those which would take them to California. Although some of the wild Monarchs that were tagged in Boise in the 1970's (by school teachers Faye Sutherland and Mary Henshall) flew to California, others were recovered from distances of up to 750 km in



FIG. 1. Monarch butterfly with tag used in this study.

a south easterly direction in Utah (Pyle 1999, 2015). Pyle (1999) in his autumn journey from British Columbia to Mexico encountered migrating Monarchs in the inland PNW and the Great Basin and noted their vanishing bearings. Fifty three of 62 Monarchs in this region gave vanishing bearings toward the south and south east (Brower and Pyle 2004). These bearings would lead migrating western Monarchs to Mexico, a hypothesis supported by Pyle's observations in New Mexico of Monarchs flying south to Mexico just 16 km away (Pyle 1999, 2015). Indirect evidence of the origin of Monarchs in California overwintering colonies based on spatial analyses of stable isotope ratios was recently provided by Yang et al. (2015). While these data supported the hypothesis that some PNW Monarchs migrate to California they did not exclude the possibility that others may overwinter elsewhere. Morris et al. (2016) presented data showing Monarchs tagged in Arizona migrate to both California and Mexico overwintering sites, the first hard evidence that western Monarchs may overwinter in Mexico.

Given the history of efforts to understand the seasonal movements of Monarchs in the PNW and the equivocal nature of conclusions drawn from limited or flawed experiments, we commenced a program of tagging in 2012. Conducted primarily on PNW-sourced Monarchs both reared and wild, we present the results here from our first five years.

MATERIALS AND METHODS

Annual rearing of *Danaus plexippus* for tagging was conducted in multiple locations throughout the Pacific Northwest (British Columbia, Washington, Idaho, Oregon and Nevada) during 2012–2016. Inmates at the

Washington State Penitentiary (WSP), Walla Walla, WA reared and tagged Monarchs in each year of the five year program. Eggs and first instar larvae produced by female *D. plexippus* obtained from breeding populations in far northern California (Trinity River National Forest) or central Washington, were provided to WSP inmates who then reared the larvae to adulthood (James 2016). Adults were tagged by inmates and released in the Penitentiary grounds or taken to nearby locations for release by Penitentiary staff. In 2012, white tags showing an email address and serial number were manufactured at WSP but in subsequent years customized white tags were obtained from MonarchWatch.org. Rearing of Monarchs was adopted by WSP as a way of improving the mental health of long term inmates by giving them a purpose and focus to their lives (James 2016). Rearing was also conducted at Prosser and Yakima, WA (DGJ, TSJ, LS) and in Bayview, ID (BH, Bill Ament). During 2014–16, citizen scientists in south west Oregon, north and central Oregon, British Columbia and Idaho reared and tagged Monarchs. The vast majority of Monarchs were reared from locally-obtained livestock in WA, OR and ID. However, in the first two years of the project ~ 500 Monarchs released in WA and ID were reared from stock originating from a mid-California butterfly farm (Table 1). All rearers were aware of the importance of cleanliness in preventing disease. Gravid females from which livestock were obtained in WA and ID were checked during 2014–16 for the presence of protozoan parasite *Ophryocystis elektroscirrha* (OE) spores (Altizer and de Roode 2015) and not used for egg-laying if they tested positive. The incidence of OE-affected wild adults was low (< 5 %). Mass-rearing was conducted only once in each location each season to prevent disease and OE build-up. Tags were placed on the mitten-shaped or discal cell on the ventral surface of a hindwing (Fig. 1). All Monarchs were tagged with a single tag except for 264 (2014) and 631 (2015) reared/released at Yakima, WA which were 'double tagged', ie they had a single tag on each hindwing. None of these double-tagged Monarchs was recovered. From 2013–2016, wild Monarchs in Washington, Idaho, Oregon and northern California were also opportunistically tagged during May–September. For all tagged Monarchs, the date of tagging/release, name of tagger, tag number, location of release and the sex of the butterfly were recorded.

Tagged Monarchs were recovered by citizens sighting and/or photographing the butterfly and emailing the address on the tag. Two of the authors (DGJ & TSJ) conducted eight visits of four to eight days each to a total of 37 north and central California overwintering

TABLE 1. Coastal California Monarch overwintering sites visited and searched by DGJ and TSJ for tagged Monarchs during 2013–16.

Period of Visit	Monarch Overwintering Sites Visited
November 27–30 2013 (4 days)	Santa Cruz (Natural Bridges, Lighthouse Field, Moran Lake), Pacific Grove, Ardenwood, Bolinas (Kale & Juniper, Agate Ck.)
November 26–29 2014 (4 days)	Santa Cruz (Natural Bridges, Lighthouse Field, Moran Lake), Pacific Grove, Andrew Molera SP, Monterey,
December 28–January 3 2014/15 (7 days)	Goleta (Ellwood, Maria Ygnacio Ck. San Jose Ck.), Ventura (Ocean Ave. Park), Gaviota Beach, Pismo (Halcyon Hill, Oceano CG., State Beach), Andrew Molera SP, Pacific Grove, Monterey, Santa Cruz (Natural Bridges, Lighthouse Field, Moran Lake)
November 22–28 2015 (7 days)	Goleta (Ellwood, Maria Ygnacio Ck. San Jose Ck.), Carpinteria Creek, Ventura (Ocean Ave. Park, Camino Real Park, Arrundel Barranca), Gaviota Beach, Nipomo-Trilogy, Pismo (Halcyon Hill, Oceano CG., State Beach), Morro Bay CG., Los Osos, Andrew Molera SP, Pacific Grove, Monterey, Santa Cruz (Natural Bridges, Lighthouse Field, Moran Lake), Ardenwood Farm, Bolinas (Kale & Juniper, Agate Ck.)
December 27–January 1 2015/16 (6 days)	Gaviota Beach, Nipomo-Trilogy, Pismo (Halcyon Hill, Oceano CG., State Beach), Morro Bay CG., Andrew Molera SP, Pacific Grove, Monterey, Santa Cruz (Natural Bridges, Lighthouse Field, Moran Lake), New Park Mall (Newark), Ardenwood Farm, Stinson Beach, Bolinas (Kale & Juniper, Agate Ck.)
February 2–5 2016 (4 days)	Santa Cruz (Escalona, Potbelly, Sunscape), Bolinas (Kale & Juniper, Agate Ck.), Albany Hill, Berkeley Aquatic Park, San Leandro G.C., New Park Mall (Newark)
November 19–25 2016 (7 days)	Goleta (Ellwood, Tecolote), Carpinteria (Creek, Dump), Ventura (Ocean Ave, Park), Santa Barbara (Padaro Lane 2 sites), Gaviota Beach, Nipomo-Trilogy, Pismo (Halcyon Hill, Oceano CG., State Beach), Morro Bay (CG., Del Mar Park, Toro Creek), Cayucos (Villa Creek), Andrew Molera SP, Pacific Grove, Santa Cruz (Natural Bridges, Lighthouse Field, Moran Lake, Escalona, Aptos GC, Branciforte Avenue), New Park Mall (Newark), San Leandro G.C., Albany Hill, Berkeley Aquatic Park, Stinson Beach, Bolinas (Kale & Juniper, Agate Ck.)
December 27–January 1, 2017 (6 days)	Pismo (Halcyon Hill, Oceano CG., State Beach), Morro Bay (CG., Del Mar Park, Toro Creek), Cayucos (Villa Creek), Esalen (Big Sur), Cambria (Hamlet), Santa Cruz (Lighthouse Field, Moran Lake, Escalona, Branciforte Avenue), New Park Mall (Newark), San Leandro G.C., Albany Park, Muir Beach, Stinson Beach, Bolinas (Purple Gate, Kale & Juniper, Agate Ck.)

RESULTS

colonies during 2013–16 (Table 1). In 2016, substantial searching of overwintering colonies during October to January 2017 for tagged Monarchs was also conducted by Joe Billings, an Arizona-based naturalist with MonarchQuestAZ. John Dayton, a Monarch biologist located in Santa Cruz frequently visited local overwintering sites (primarily Lighthouse Field, Natural Bridges, Moran Lake) during October–February in each year and reported tags. Most citizen and author recoveries of tagged Monarchs were supported by a confirmatory photograph. Recoveries of Monarchs within 10 kilometers of the release point were considered ambiguous and are not reported here. Date, location and tag number were recorded for all recovered Monarchs and straight-line distances from release to recovery locations, calculated.

A total of 13778 Monarchs were reared and tagged in the PNW during summer and fall 2012–16 with the number tagged each year ranging between 1756 and 3863 (Table 2). In addition, 875 wild Monarchs were tagged during 2013–16 (Table 3). A total of 60 tagged Monarchs were recovered during this study representing 0.41% of the butterflies tagged (Tables 4–6, Figs. 2–4). All but three recoveries were of butterflies reared from locally-sourced livestock (Table 4). All recoveries were of reared butterflies; no wild Monarchs tagged in Washington, Idaho or Oregon were recovered. A substantial increase in recoveries occurred in later years of the project with 80% of the recoveries occurring in 2015 and 2016 (Fig. 5). The majority (36.7%) of Pacific Northwest fall migrants were found in California, SSW of release points (Figs. 2, 4 & 6).

TABLE 2. Numbers of Monarchs reared and tagged by organizations and citizen scientists in the Pacific Northwest during 2012-16 (WSP = Washington State Penitentiary; WSU = Washington State University; CCC = Cowiche Canyon Conservancy; CWI = College of Western Idaho, IDFG = Idaho Fish and Game, IMNH = Idaho Museum of Natural History, USFWS = United States Fish and Wildlife Service). Origin (state) of reared Monarchs shown in parentheses after totals (CAF = California farm-sourced). Names of citizen taggers are shown in acknowledgments.

Location	2012	2013	2014	2015	2016	2012-2016
Washington						
	1310 (472 N CA, 834 WA)	1307 (482 N CA, 815 WA)	880 (419 N CA, 461 WA)	1390 (738 N CA, 652 WA)	242 (128 N CA, 114 WA)	
WSP (Walla Walla, Pasco)	Jul 7-Oct 4	Jul 1-Sep 23	Jul 1-Oct 13	Jul 6-Oct 20	Jul 4-Sep 2	5129
	620 (408 CAF, 158 WA, 54 N CA)	449 (333 WA, 87 CAF, 29 N CA)	1035 (884 WA, 151 N CA)	1097 (656 WA, 441 N CA)	1254 (WA)	
WSU (Yakima, Prosser)	Jul 7-Oct 15	Jul 31-Oct 25	Aug 22-Oct 19	Jul 1-Oct 21	Aug 17-Oct 20	4455
CCC (Yakima)				60 (WA) Sep 11-29	152 (WA) Aug 26-Sep 14	212
Citizens (Redmond, Vancouver)				136 (CAF) Aug 27-Oct 16	40 (WA) Sep 18-22	176
Total (WA)	1930	1756	1915	2683	1688	9972
Idaho						
IDFG (Bayview)	451 (CAF) Aug 9-Sep 13		241 (ID) Aug 11-Sep 25	252 (ID) Aug 27-Oct 14	116 (CAF) Aug 6-18	1060
CWI (Nampa)					30 (ID) Oct 6-26 27 (ID) Jul 7-Sep 12	30 27
IMNH						27
Citizens (Boise, Blackfoot, Nampa)				5 (ID) Jul 4-Sep 12	75 (ID) Jul 5-Oct 26	80
Total (ID)	451	0	241	257	248	1197
S. Oregon & N. CA						
Citizens (Applegate, Eugene, Medford, Port Orford, Brookings, Talent, Elkton, Jacksonville, Williams, Gold Hill, Wonder, Redding (CA))			60 (OR) Jun 10-Oct 6	849 (OR) Jul 1-Nov 1	1211 (OR) Jul 1-Oct 26	2120
USFWS					221 (OR) Jul 1-Oct 18	221
Total (S. OR & N. CA)	0	0	60	849	1432	2341
N & C Oregon						
Citizens (Corvallis, Portland, Bend, Newberg, Crow)				44 (OR) Jul 1-27	120 (OR) Jul 13-Aug 30	164
British Columbia						
Citizen (Naramata)			53 (BC)			53
Nevada						
Citizens (Reno, Verdi, Sparks)				30 (NV) Jul 10-Aug 18	21 (NV) Aug 23-Oct 6	51
Total (PNW)	2381	1756	2269	3863	3509	13778



FIG. 2. Directions traveled and destinations of Monarchs reared and tagged in Washington during July-September 2012-16.



FIG. 3. Directions traveled and destinations of Monarchs reared and tagged in Oregon during August-October 2014-16.



FIG. 4. Directions traveled and destinations of Monarchs reared and tagged in Idaho during August-October 2012-15.

One tagged Monarch was recovered in Brigham City, Utah, 724 km south east of its release point in Walla Walla, WA (Fig. 2). One male traveled 20 km east from Prosser to Benton City in WA while a female from Brookings, OR was found 84 km to the ENE in Williams, OR. All but one of the remaining 13 (23.3%) Monarchs that had an easterly component to their flight (SSE) originated in central or southern OR and their slight easterly orientation was likely influenced by the NW-SE oriented CA coastline (Fig. 3). The exception was released in Yakima, WA but had only traveled 32 km SSE before recovery. The majority of migrants from

Washington (63.3%) were recovered in locations SSW of their release points (Figs 2 & 6). In contrast, the majority of migrants from Oregon (46.1%) were recovered SSE of release points (Figs. 3 & 6). Two of three recovered Idaho Monarchs were found due south of release points at 93 and 124 km (Figs. 4 & 6). Forty nine recoveries of Washington and Oregon-released Monarchs were made at 24 coastal California overwintering sites during October-February, 22 of these occurred in 4 Santa Cruz overwintering colonies (Table 7, Figs. 2-3). Two individuals were recovered at more than one overwintering site (Table 6, see below).

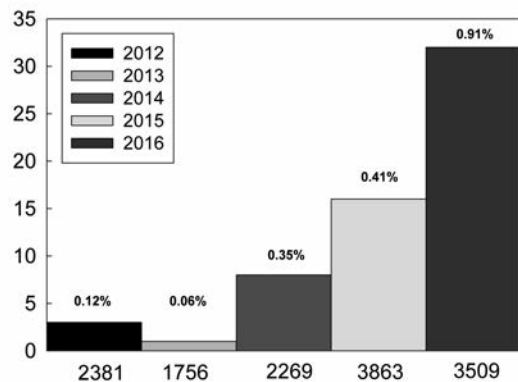


FIG. 5. Number of PNW-tagged Monarchs recovered annually during 2012-16. Numbers above and below each bar represent percentage recovery rate and the number of Monarchs reared and tagged in each year, respectively.

Twelve tagged Monarchs were found at the Lighthouse Field overwintering site in Santa Cruz during the study. Remarkably, seven of these migrated from the same location in Yakima, WA (2 in 2014, 5 in 2016). The second most popular location for recoveries (7) was Bolinas and 5 were recovered at three Morro Bay overwintering sites (Table 8). In 2016, 10 of 15 recoveries of Yakima, WA Monarchs were released within a 48 hour period (20–22 August). These butterflies were found at overwintering sites in Santa Cruz (4), Bolinas (2), San Leandro (1), Goleta (1), Morro Bay (1) and en route at Anapolis, CA (1), north of San Francisco. Thirteen tagged Monarchs were recovered during the fall migration before arrival at overwintering sites, showing a mean (\pm SE) travel rate of 35.1 ± 4.3 km/day (Table 8). No Idaho Monarchs were recovered at California overwintering sites but three were reported during migration at distances of 93–209 km south or south-west of release points (Fig. 4). The greatest straight line release point to recovery point distance was 1360 km from Yakima, WA to Tecolote Canyon near Goleta, CA (Table 6). The mean distance traveled by the 60 recovered butterflies was 792.9 ± 48.0 km. Washington-released Monarchs traveled further (994.9 ± 67.4 km, $n = 29$) than central Oregon (945.0 ± 180.5 km, $n = 2$), southern Oregon (823.2 ± 191.8 km, $n = 26$) or Idaho (142 ± 34.7 km, $n = 3$) Monarchs. Of the 60 tagged Monarchs that were recovered, 29 (48.4%) originated in Washington, 26 (43.3%) in southern Oregon, 3 (5.0%) in Idaho and 2 (3.8%) in north-central Oregon. The percentage recovery rate was higher in southern (1.1%) and northern-central (1.2%) Oregon Monarchs than Washington (0.29%) or Idaho (0.25%) Monarchs.

In Washington the recovery rate was higher for Yakima-released Monarchs (0.40 %) than Monarchs released 180 km further east at Walla Walla (0.12 %). A single wild Monarch tagged as it was migrating in late spring along the Trinity River in far northern California, was recovered 35 days later and 707 km ENE in Twin Falls, Idaho (20.2 km/day) (Table 9, Fig. 7).

Residency and inter-colony movement of tagged monarchs at overwintering sites.

Seventeen tagged Monarchs sighted at overwintering colonies were re-sighted two to six times in the same colonies 3 to 123 days (Mean 28.5 ± 6.7) later (Table 10). Two tagged Monarchs were re-sighted in different overwintering colonies. One of these (A4853 released in Corvallis, OR, August 30 2016) was seen at three Santa Cruz overwintering sites during October 11–December 30 following its original sighting in North Beach, San Francisco (Table 6, Fig. 8). A6504 was seen at two Carpinteria overwintering sites (Table 6).

DISCUSSION

This study provides definitive evidence that many Monarchs in Washington and Oregon migrate south in late summer and fall to a range of overwintering sites along the California coast from Marin County, north of San Francisco to Carpinteria in Santa Barbara County just north of Ventura. The rate of recovery of tagged Monarchs increased substantially during the project. The number of butterflies we tagged also increased annually but not to the same extent as recoveries. It is possible or even likely that the recent increased awareness of Monarchs among the general public and the ubiquity of cell phone cameras have conspired to make the reporting of tagged Monarchs easier and more frequent.

Forty nine reared and tagged Monarchs from Washington and Oregon were recovered at California overwintering sites while 13 were recovered during migration, most heading south to south west towards California. One Washington-released Monarch was recovered at an I-84 rest stop just north of Brigham City, Utah, 724 km south east of its release point at Walla Walla. If this individual arrived at this location under its own power, then it clearly was not heading towards the California coast and may have been orienting towards Arizona and Mexico. Interestingly, no Monarchs reared and tagged in Idaho were recovered in California. Only three Idaho Monarchs were recovered and two of these were heading south following routes that if continued would lead them towards Mexico rather than California. These records of south-easterly and southerly-vectoring Monarchs



FIG. 7. Spring remigration. Direction traveled and destination (Twin Falls, ID) of a wild Monarch tagged on May 24 2015 in the Trinity National Forest, CA.

from eastern Washington and Idaho support the 1970s data of Idaho schoolteachers Faye Sutherland and Mary Henshall as well as the suggestions of Dingle et al. (2005) and observations of Pyle (1999, 2015), that postulate at least some Monarchs in the eastern portion of the PNW do not migrate to California.

In our study we reared and tagged 1197 Monarchs in Idaho and the recovery rate of 0.25 % was comparable to that from the 9972 Monarchs we reared and tagged in Washington (0.29 %). Morris et al. (2015) also obtained a 0.2 % recovery rate (in Mexico and California) from 12,088 wild Monarchs tagged in Arizona during an 11 year period. However, Joe Billings (MonarchQuest AZ) recorded a 1.44 % recovery rate (in Mexico and California) for wild-tagged Monarchs in Arizona during 2014-16 (J. Billings, pers. Comm.). The recovery rate for Oregon-reared Monarchs was 1.1–1.2 %, similar to the recovery rate for tagged eastern US Monarchs (1.2%) during 1998–2015 (<http://monarchwatch.org/blog/2016/11/02/tagging-results-and-the-monarch-decline/>). In Virginia, a difference in recovery rates in Mexico for Monarchs tagged in a coastal (1.29 %) and a more inland location (0.16 %), <200 km apart, was reported by Brindza et al. (2008). At two locations in Washington (Yakima, Walla Walla) where substantial numbers of tagged Monarchs were released, the recovery rate for the more eastern site (Walla Walla: 180 km east of Yakima) was lower (0.12 %) than for Yakima (0.40 %). Lower recovery rates for eastern Washington and Idaho Monarchs possibly indicate that a proportion of the Monarch population in these areas migrate through landscapes less populated by people with a reduced chance of being sighted and reported. Migration south or south-easterly would take Monarchs for more than 2000 km through sparsely settled areas of Idaho, Utah and Arizona. Clearly, far

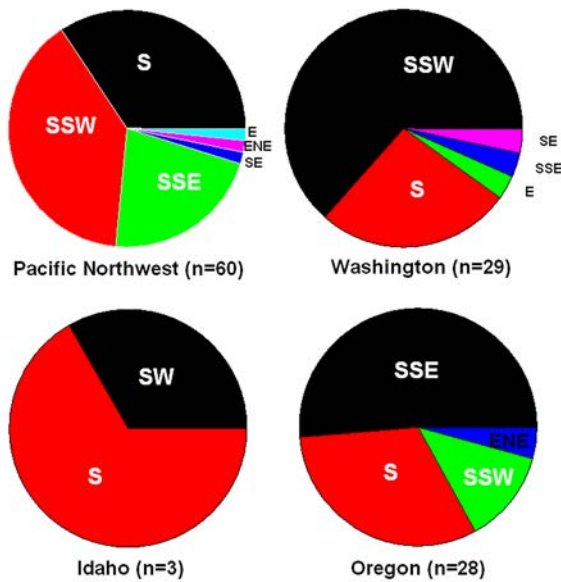


FIG. 6. Proportional representation of directions traveled by tagged Monarchs released in the Pacific Northwest during 2012-16 and recovered at distances > 10 km from release points.

TABLE 3. Numbers of wild Monarchs tagged by citizen scientists and agency personnel (WSU, IDFG, CWI, USFWS) in the Pacific Northwest during 2013–16

Location	2013	2014	2015	2016	2013–16
Washington					
Yakima	1	0	0	2	3
Vantage	24	163	79	70	336
Roosevelt	0	2	0	0	2
Moses Lake	0	0	5	0	5
Prosser	0	0	1	0	1
Total (WA)	25	165	85	72	347
Idaho					
Pocatello	0	0	5	1	6
Boise	0	0	13	51	64
Nampa	0	0	1	28	29
Glenn's Ferry	0	0	0	1	1
Horseshoe Bend	0	0	0	6	6
Payette	0	0	0	3	3
Aberdeen	0	0	0	10	10
Salmon	0	0	0	19	19
Montpelier	0	0	0	6	6
Jerome Co.	0	0	0	5	5
Twin Falls Co.	0	0	0	21	21
Wendell	0	0	0	1	1
Jefferson Co.	0	0	0	11	11
Bingham Co.	0	0	0	18	18
Oneida Co.	0	0	0	8	8
Owyhee Co.	0	0	0	27	27
Gooding Co.	0	0	0	2	2
Total (ID)	0	0	19	218	237

TABLE 3. Continued.

Location	2013	2014	2015	2016	2013-16
Southern Oregon					
Southern Oregon					
Applegate	0	19	43	43	105
Talent	0	0	16	1	17
Medford	0	0	17	8	25
Malheur	0	0	2	0	2
Elkton	0	0	0	2	2
Klamath Falls	0	0	0	1	1
Total (S. OR)	0	19	78	55	152
Northern & Central Oregon					
Umatilla	0	0	12	0	12
Corvallis	0	0	0	12	12
Portland	0	0	0	4	4
Bend	0	0	0	5	5
Clarno	0	0	0	6	6
Total N & C Oregon	0	0	12	27	39
Nevada					
Reno	0	0	4	42	46
N. California					
Eagle Ck, Trinity NF	0	0	21	32	53
Total (PNW)	25	184	219	447	875

TABLE 4. Release, recovery and distance data for Monarchs reared, tagged and released in the PNW during 2012-14.

Tag #	Sex	Release Location	Release Date & Tagger	Recovery Location	Recovery Date	Distance (kilometers & direction)	Finder
1837 [°]	Female	Walla Walla, WA	July 13 2012 WSP	Brigham City, UT	August 3 2012	724 SE	Michael Sell
260 ^{°°}	Female	Post Falls, ID	August 15 2012 Bill Harryman	Potlatch, ID	August 18 2012	93 S	Judi Rohn
3172 ^{°°}	Female	Yakima, WA	September 17 2012 David James	Agate Ck., Bolinas, CA (OS)	October 30 2012	998 SW	Rose Poulsen
1076	Female	Walla Walla, WA	September 18 2013 WSP	Milton-Freewater, OR	October 26 2013	11 S	Gayle Blomme
6949	Male	Prosser, WA	September 4 2014 Lorraine Seymour	Benton City, WA	September 7 2014	20 E	Stephen Zetz
7024	Male	Yakima, WA	September 4 2014 David James	Glen Ellen, CA	September 27 2014	1030 SSW	David Hamilton
5741	Female	Stateline, ID	September 25 2104 Bill Ament	Walla Walla, WA	October 3 2014	209 SW	Esther Schluter
0683	Female	Applegate, OR	September 30 2014 Linda Kappen	San Mateo, CA	October 10 2014	531 S	Albert Fong
3524	Male	Yakima, WA	August 25 2014 David James	Lighthouse Field, Santa Cruz, CA (OS)	November 21 2014	1085 SSW	John Dayton
5925	Female	Walla Walla, WA	September 5 2014 WSP	Maria Ygnacio Ck., Goleta, CA (OS)	November 22 2014	1336 S	Charis van der Heide
6416	Male	Yakima, WA	August 29 2014 David James	Lighthouse Field, Santa Cruz, CA (OS)	November 28 2014	1085 SSW	Jasmine James
6996	Male	Prosser, WA	September 7 2014 Lorraine Seymour	Pacific Grove, CA (OS)	January 3 2015	1094 SSW	David James

[°]Source: reared from wild-collected N California female (May 2012)

^{°°}Source: reared from CA commercial butterfly farm stock. All other recoveries derived from local (to release point) brood stock. OS = overwintering site. WSP = Washington State Penitentiary

TABLE 5. Release, recovery and distance data for Monarchs reared, tagged and released in the PNW during 2015. OS = overwintering site

Tag#	Sex	Release Location	Release Date & Tagger	Recovery Location	Recovery Date (additional sighting)	Distance (kilometers & direction)	Finder
A3328	Male	Rathdrum, ID	August 28 2015 Bill Harryman	Troy, ID	September 9 2015	124 S	Gerry Queener
A3001	Female	Brookings, OR	August 31 2015 Vicki Mion	Williams, OR	September 10 2015	84 ENE	Michelle Scherer
A3223	Male	Brookings, OR	September 17 2015 Vicki Mion	Aptos, CA	October 16 2015	612 SSE	Deb Ospina
A0578	Male	Walla Walla, WA	September 8 2015 WSP	Morro Bay SP CG CA (OS)	October 21 2015	1247 SSW	Regena Orr
A3771	Male	Applegate, OR	October 5 2015 Tyler Kappen	Boonville CA	October 23 2015	365 SSW	Beth Swehla
A2099	Male	Medford, OR	September 9 2015 Tiffany Wyatt	Villa Ck., Cayucos, CA (OS)	October 28 2015	801 S	Paul Cherubini
A2067	Female	Applegate, OR	August 19 2015 Linda Kappen	Natural Bridges SB, Santa Cruz, CA (OS)	November 16 2015 (November 28 2015)	604 SSW	Andrea & Denise, David James
A2062	Male	Applegate, OR	August 19 2015 Linda Kappen	Moran Lake, Santa Cruz, CA (OS)	November 10 2015 (November 26 2015)	605 SSW	John Dayton, David James
A3264	Male	Applegate, OR	September 17 2015 Linda Kappen	Pismo Beach SP (OS)	November 24 2015 (December 28 2015)	861 SSE	David James
A0417	Male	Pasco, WA	September 7 2015 WSP	Morro Bay SP CG CA (OS)	November 24 2015	1247 SSW	David James
A0508	Male	Pasco, WA	September 7 2015 WSP	Moran Lake, Santa Cruz, CA (OS)	November 26 2015 (December 30 2015)	1078 SSW	David James, Tanya James & John Dayton
4789	Female	Talent, OR	August 19 2015 Aleece Townsend	Kale Road, Bolinas, CA (OS)	November 28 2015 (December 10 2015)	486 S	David James, Paul Cherubini
A3712	Female	Brookings, OR	September 13 2015 Vicki Mion	Kale Road, Bolinas, CA (OS)	November 28 2015	483 SSE	Tanya James
A0354	Male	Touchet, WA	September 6 2015 WSP	New Park Mall, Newark, CA (OS)	December 31 2015	991 SSW	David James
A2045	Male	Medford, OR	September 26 2015 Robert & Simone Coffan	Kale Road, Bolinas, CA (OS)	January 1 2016 (February 3 2016)	502 S	David James
A3063	Male	Talent, OR	October 4 2015 Aleece Townsend	Agate Ck., Bolinas CA (OS)	January 1 2016	486 S	David James

TABLE 6. Release, recovery and distance data for Monarchs reared, tagged and released in the PNW during 2016. OS = overwintering site.

Tag #	Sex	Release Location	Release Date & Tagger	Recovery Location	Recovery date (additional sighting)	Distance (kilometers & direction)	Finder
A6093	Male	Ashland, OR	Aug 28 2016 Steven Johnson	Vacaville, CA	Sept 5 2016	457 S	Kathy Keatley Garvey
A7079	Female	Brookings, OR	Aug 30 2016 Patsy Haggerty	Windsor, CA	Sept 6 2016	438 SSE	Mike & Barbara Schumacher
B2838	Male	Yakima, WA	Aug 22 2016 David James	Anapolis, CA	Sept 14 2016	917 SSW	Jane Simmonds
A 4853 (seen at 4 locales)	Female	Corvallis, OR	Aug 30 2016 Molly Monroe & Amelia Jebousek	San Francisco, CA (1) Lighthouse Field, Santa Cruz, CA, (OS) (2) Natural Bridges SB, Santa Cruz CA (OS) (3) Moran Lake, Santa Cruz, CA (OS) (4)	Sept 18 2016 (1) (Oct 11 2016 (2) Nov 25 2016 (3) Dec 30 2016 (4))	765 S 103 SSE (from location 1) 2.6 W (from location 2) 7.4 E (from location 3)	Lisa de Angelis, John Dayton, Aleece Townsend, David James
B2701	Male	Yakima, WA	Aug 21 2016 David James	Lighthouse Field, Santa Cruz, CA (OS)	Sept 30 2016 (1) (Jan 6 2017 (2) Jan 9 2017 (3) Feb 1 2017 (4))	1085 SSW	John Dayton, David James
B4112	Female	Yakima, WA	Oct 2 2016 David James	Wapato, WA	Oct 8 2016	32 SSE	Heinz Humann
A2705	Female	Talent, OR	Aug 17 2016 Aleece Townsend	Natural Bridges SB, Santa Cruz, CA (OS)	Oct 10 2016	591 SSE	Steve Cary
B2174	Female	Yakima, WA	Sept 8 2016 Cindy Dunbar	Morro Bay SP CG CA (OS)	Nov 1 2016	1275 S	Regena Orr
A6935	Female	Brookings, OR	Aug 25 2016 Andrea Christensen	Lighthouse Field, Santa Cruz, CA (OS)	Nov 5 2016 (1) (Nov 28 2016 (2), Nov 30 2016 (3))	618 SSE	John Dayton, Joe Billings
B2452	Male	Redmond, WA	Sept 20 2016 Connie Granberg	Lighthouse Field, Santa Cruz, CA (OS)	Nov 5 2016 (1) (Nov 25 2016 (2))	1207 S	John Dayton, Aleece Townsend
B2729	Male	Yakima, WA	Aug 21 2016 David James	Natural Bridges SB, Santa Cruz, CA (OS)	Nov 7 2016	1085 SSW	John Dayton
B2742	Male	Yakima, WA	Aug 21 2016 David James	Lighthouse Field, Santa Cruz, CA (OS)	Nov 13 2016 (1) (Nov 23 2016 (2), Nov 30 2016 (3), Dec 12 2016 (4), Dec 30 2016 (5), Jan 6 2017 (6))	1085 SSW	John Dayton, David James
A6504 (seen at 2 locales)	Male	Sisters, OR	Sept 17 2016 Susie Werts	Carpinteria Ck., CA (OS) (1) Dump Road, Carpinteria CA (OS) (2)	Nov 11 2016 (1) (Nov 22 2016 (1), Jan 11 2017 (2), Jan 23 2017 (2), Jan 26 2017 (2))	1126 SSE, 0.6 E (from location 1)	Joe Billings, David James

TABLE 6. Continued.

Tag #	Sex	Release Location	Release Date & Tagger	Recovery Location	Recovery date (additional sighting)	Distance (kilometers & direction)	Finder
B3554	Male	Elkton, OR	Sept 23 2016 Barbara Slott/Kris Hendricks	Ardenwood Historic Farm, Fremont, CA (OS)	Nov 11 2016 (1) (Nov 16 2016 (2))	694 SSE	Paul Cherubini, Christine Garcia
B2603	Male	Yakima, WA	Aug 20 2016 David James	Toro Ck., Cayucos CA (OS)	Nov 13 2016	1247 S	Joe Billings
B3587	Female	Talent, OR	Sept 27 2016 Aleece Townsend	Del Mar Park, Morro Bay (OS)	Nov 19 2016	798 SSE	Joe Billings
B3202	Male	Yakima, WA	Sept 9 2016 David James	Lighthouse Field, Santa Cruz, CA (OS)	Nov 23 2016	1085 SSW	David James
B2766	Male	Yakima, WA	Aug 21 2016 David James	Lighthouse Field, Santa Cruz, CA (OS)	Nov 23 2016 (1) (Nov 25 2016 (2)), Nov 30 2016 (3))	1085 SSW	David James, Aleece Townsend, John Dayton
A6195	Male	Elkton, OR	Sept 2 2016 Barbara Slott/Kris Hendricks	Branciforte Drive, Santa Cruz, CA (OS)	Nov 23 2016	768 SSE	David James
B2604	Female	Yakima, WA	Aug 20 2016 David James	San Leandro GC, CA (OS)	Nov 24 2016	1006 SSW	David James
B2682	Male	Yakima, WA	Aug 21 2016 David James	Kale Road, Bolinas, CA (OS)	Nov 25 2016	998 SSW	David James
B2837	Female	Yakima, WA	Aug 22 2016 David James	Kale Road, Bolinas, CA (OS)	Nov 25 2016	998 SSW	David James
A6205	Female	Elkton, OR	Sept 2 2016 Barbara Slott, Kris Hendricks	Lighthouse Field, Santa Cruz, CA (OS)	Nov 30 2016 (1) (Dec 30 2016 (2)), Jan 6 2017 (3))	753 S	John Dayton, David James
A6189	Male	Elkton, OR	Sept 2 2016 Barbara Slott, Kris Hendricks	Esalen Institute, Big Sur, CA (OS)	Dec 2 2016	850 S	Joe Billings
B3038	Male	Yakima, WA	Sept 2 2016 David James	Las Varas Ranch, Goleta, CA (OS)	Dec 14 2016 (1) (Jan 7 2017 (2))	1357 S	Joe Billings
B3390	Female	Yakima, WA	Sept 18 2016 David James	Lighthouse Field, Santa Cruz, CA (OS)	Nov 30 2016 (1) (Dec 9 2016 (2)), Dec 30 2016 (3))	1085 SSW	John Dayton, David James
B2832	Female	Yakima, WA	Aug 22 2016 David James	Tecolote Canyon, Goleta, CA (OS)	Dec 14 2016	1360 S	Jessica Griffiths
A7393	Male	Applegate, OR	Aug 27 2016 Kirsten & Jakob Shockey	Cambria, CA (OS)	Dec 29 2016 (1) (Jan 1 2017 (2))	761 SSE	David James, Joe Billings
A6879	Female	Wilderville OR	Aug 21 2016 LaDawn Wilhelm	Purple Gate, Bolinas, CA (OS)	Jan 1 2017	502 S	David James
A6188	Male	Elkton, OR	Sept 2 2016 Barbara Slott/Kris Hendricks	Ellwood, Goleta, CA (OS)	Jan 9 2017	1071 SSE	Joe Billings
B3555	Male	Elkton, OR	Sept 23 2016 Barbara Slott/Kris Hendricks	Dump Road, Carpinteria, CA (OS)	Jan 20 2017	1085 SSE	Joe Billings
B3510	Male	Applegate, OR	Sept 25 2016 Linda Kappen	Lighthouse Field, Santa Cruz, CA (OS)	Feb 9 2017	597 S	Bill Henry

TABLE 7. California overwintering sites at which Pacific Northwest-tagged Monarchs were recovered during 2012–16

Overwintering site	Washington -released	Southern Oregon-released	North-central Oregon-released	Total
Santa Cruz-Lighthouse Field	8	3	1	12
Santa Cruz-Natural Bridges	2	2	1	5
Santa Cruz-Moran Lake	2	1	1	4
Santa Cruz-Branciforte	0	1	0	1
Bolinas-Kale	2	3	0	5
Bolinas-Agate	0	1	0	1
Bolinas-Purple Gate	0	1	0	1
Morro Bay-SPCG	3	0	0	3
Morro Bay-Del Mar Park	0	1	0	1
Morro Bay-Toro Creek	1	0	0	1
Carpinteria-Dump Road	0	1	1	2
Carpinteria Creek	0	0	1	1
Cayucos-Villa Creek	0	1	0	1
Cambria	0	1	0	1
Esalen-Big Sur	0	1	0	1
Pacific Grove	1	0	0	1
Pismo Beach	0	1	0	1
Goleta-Ellwood	0	1	0	1
Goleta-Maria Ygnacio Creek	1	0	0	1
Goleta-Las Varas	1	0	0	1
Goleta-Tecolote Creek	1	0	0	1
San Leandro GC	1	0	0	1
Ardenwood Farm	0	1	0	1
New Park Mall-Newark	1	0	0	1
TOTAL	24	20	5	49

TABLE 8. Distance and daily rate of travel shown by 13 reared and tagged fall-migrating Monarchs.

Tag #	Release-Recovery locations	Distance traveled (km)	Release-Recovery period (days)	Rate of travel (km/day)
1837	Walla-Walla WA – Brigham City UT	724	21	34.5
260	Post Falls ID – Potlatch ID	93	3	31.0
3172	Yakima WA – Bolinas CA	998	43	23.2
7024	Yakima WA – Glen Ellen CA	1030	23	44.8
5741	Stateline ID – Walla Walla WA	209	9	23.2
0683	Applegate OR – San Mateo CA	531	11	48.3
A3328	Rathdrum ID – Troy ID	124	12	10.3
A3223	Brookings OR – Aptos CA	612	29	21.1
A3771	Applegate OR – Boonville CA	365	18	20.3
A6093	Ashland OR – Vacaville CA	457	8	57.1
A7079	Brookings OR = Windsor CA	438	7	62.6
B2838	Yakima WA – Anapolis CA	917	23	39.8
A4853	Corvallis OR – San Francisco CA	765	19	40.3
MEAN (±) SE		558.7 ± 88.0	17.4 ± 3.0	35.1 ± 4.3

TABLE 9. Release, recovery and distance data for a wild Monarch tagged in northern California in late spring 2015.

Tag #	Sex	Release location	Release date	Recovery location	Recovery date	Distance (kilometers) & Direction	Finder
4130	Male	Eagle Creek Trinity River N CA	May 24 2015	Twin Falls ID	June 28 2015	707 ENE (spring migrant)	Kendra Hathaway

TABLE 10. Tagged Monarchs seen multiple times at California overwintering sites during 2015–16.

Tag #	Overwintering site	Number of times sighted	First sighted	Last sighted	Residency at site (days)
A2067	Santa Cruz-Natural Bridges	2	Nov 16 2015	Nov 26 2015	10
A2062	Santa Cruz-Moran Lake	2	Nov 10 2015	Nov 26 2015	16
A0508	Santa Cruz-Moran Lake	2	Nov 26 2015	Dec 30 2015	34
A3264	Pismo Beach	2	Nov 24 2015	Dec 28 2015	34
4789	Bolinas-Kale	2	Nov 28 2015	Dec 10 2015	12
A2045	Bolinas-Kale	2	Jan 1 2016	Feb 3 2016	34
B2701	Santa Cruz-Lighthouse Field	4	Sept 30 2016	Feb 1 2017	123
A6935	Santa Cruz- Lighthouse Field	3	Nov 5 2016	Nov 30 2016	25
B2452	Santa Cruz-Lighthouse Field	2	Nov 5 2016	Nov 25 2016	20
B2742	Santa Cruz-Lighthouse Field	6	Nov 13 2016	Jan 6 2017	54
B2766	Santa Cruz-Lighthouse Field	3	Nov 23 2016	Nov 30 2016	7
A6205	Santa Cruz-Lighthouse Field	3	Nov 30 2016	Jan 6 2017	37
B3390	Santa Cruz-Lighthouse Field	3	Nov 30 2016	Dec 30 2016	30
B3554	Ardenwood Farm	2	Nov 11 2016	Nov 17 2016	7
B3038	Goleta: Las Varas	2	Dec 14 2016	Jan 7 2016	24
A7393	Cambria	2	Dec 29 2016	Jan 1 2016	3
A6504	Carpinteria Creek	2	Nov 11 2016	Nov 26 2016	15
A6504	Carpinteria Creek (Dump Rd)	3	Jan 11 2017	Jan 26 2017	15



FIG. 8. A Corvallis-Oregon-tagged Monarch (Tag A4853) during its migration visiting flowers on the rooftop garden of Lisa de Angelis' apartment in North Beach, San Francisco on September 18 2016. This Monarch was reared and tagged in Corvallis, Oregon on August 30 by Molly Monroe and Amelia Jebousek (Photo: Lisa de Angelis).

more Monarchs in eastern areas of the PNW need to be tagged to obtain a sufficient number of recoveries to provide a better insight into the directions taken by migrating Monarchs in this region as well as their ultimate destinations. The lack of recovery of any wild-tagged late summer/fall PNW Monarchs in this study is curious. A total of 822 wild Monarchs were tagged in Idaho, Washington and Oregon and if a 0.4% return was expected, then 3–4 individuals should have been recovered. Tagging greater numbers of wild Monarchs presumably should result in recoveries as it did in Arizona (Morris et al. 2015).

Yang et al. (2015) using spatial analyses of stable isotope ratios in the wings of 114 Monarchs overwintering at four California overwintering sites (Santa Cruz (2), Pismo Beach, Goleta) in 2009, showed great variation in the likely natal origins of these Monarchs. However, overall these data suggested an estimated 40 % of overwintering Monarchs originated in the eastern PNW (eastern WA and OR, ID). Our tagging data certainly support the notion of significant recruitment of California overwintering populations from the PNW.

Thirteen tagged Monarchs were reported 3–43 days after release and before they reached overwintering sites (Fig. 8). A mean travel rate of 35.1 km a day was recorded by these Monarchs which is a little lower than the estimated mean of 45 km/day provided by Brower et al. (2006) for a sample of 38 migrating Monarchs in the eastern US. In 2016, ten tagged Monarchs (3.7 %) from 271 released during a two day period (August 20–22) at

Yakima, WA were recovered either en route (1) or at overwintering sites (9). This exceptional recovery rate suggests that weather conditions during this narrow window of time may have been extremely beneficial for migration. The weather in southern Washington and Oregon during the four week period following this release (<https://www.wunderground.com/>) was mostly warm (daily maxima 25–30 °C) and dry, conditions highly suitable for migration. Prevailing winds during the first two weeks of September in central and northern Oregon were predominantly from the north which clearly would have been favorable for tagged Monarchs like B2838 released at Yakima on August 22 and seen at Anapolis in northern California on September 14 2016.

Washington and Oregon-tagged Monarchs were recovered in 24 coastal California overwintering colonies with most (33, 67.3 %) found in the San Francisco-Monterey area (Bolinas to Pacific Grove) sites. Twenty two (44.9%) of these recoveries were found in four Santa Cruz overwintering sites making this town the favored destination of PNW Monarchs. However, this was at least partly the result of regular inspection of colonies throughout each winter by local Monarch biologist John Dayton. Eleven (50 %) of the Monarchs found in Santa Cruz were reported by Dayton. One Santa Cruz site, Lighthouse Field, accounted for 12 tagged Monarchs with seven originating from the same backyard location in Yakima, WA. Nine tagged Monarchs were recorded in the mid-coast area (Big Sur to Pismo Beach) and a similar number (7) were recovered from the Goleta-Carpinteria area. Only three Monarchs were reported from overwintering colonies by people not associated with the project. In contrast, all 13 tagged Monarchs recovered during migration were reported by members of the public, unaware of the project. It is very likely that numbers of recoveries in the future could be increased further if volunteers living in the vicinity of overwintering sites could be recruited to regularly inspect overwintering colonies in the manner that John Dayton did in Santa Cruz during this project.

Seventeen tagged Monarchs were seen at overwintering sites on multiple occasions demonstrating residency at the sites for periods ranging from 3–123 days. However two Monarchs were sighted at more than one overwintering site and one of these was seen at three overwintering sites in the Santa Cruz area between October 11 and December 30 2016. Limited data on overwintering site fidelity and movement between sites has been reported (Nagano et al. 1993) but temporary residence at three overwintering sites in California by a single Monarch has not to our

knowledge been previously documented. Although our data on residency are limited they suggest that both types of behavior, high site fidelity and wandering occur in overwintering populations. High winds and storms likely influence inter-colony movement and this appeared to be a factor in the movement of A6504 from Carpinteria Creek to the nearby Dump Road site in 2016/17. The entire population at Carpinteria Creek dispersed in early January 2017 following a series of storms and at least some of the population (including A6504) reformed at Dump Road.

Fifty three wild spring migrants were tagged in the Trinity National Forest (along the Trinity River) in northern California in late May 2015 and 2016 and one (1.9 %) was recovered at Twin Falls in Idaho. Given the low number of individuals tagged, this recovery was unexpected and either indicates exceptional good luck or spring tagging of migrating Monarchs in northern California may yield more recoveries than tagging wild fall migrants. This is the first published record of a California-tagged spring Monarch recovered in the PNW. Nagano et al. (1993) tagged more than 50,000 Monarchs in 10 California overwintering colonies and recovered 100 at distances up to 465 km NW or E from release points, all within California and mostly during March–April. The migrants we tagged in northern California were the progeny of overwintered Monarchs. As with overwintered Monarchs it is likely that the late spring generation of migrants also migrates in northerly and easterly directions (as in Malcolm et al. (1993) for the eastern US population) with our single recovery an example of the latter. This broad range of compass directions would facilitate expansion of the Monarch population into Idaho, Utah and Montana as well as Oregon, Washington and British Columbia.

The research presented here supports the traditional assumption that Pacific Northwest Monarchs overwinter in California. Our data obtained over five years on recovery of tagged Monarchs released in the central and southern parts of both Washington and Oregon suggest that populations in these areas migrate to at least 24 overwintering sites along a 500 km section of the California coast. It seems likely that PNW Monarchs utilize the entire geographic range of coastal overwintering in California, certainly encompassing the span of noticeably large overwintering colonies from the San Francisco region to the Ventura region. Further tagging may extend this range to its northern limit in southernmost Mendocino County and/or further south to the San Diego area. We also obtained limited data indicating fall movement of some eastern Washington and Idaho Monarchs towards Utah and Arizona, reinforcing the earlier observations and suggestions of

Brower and Pyle (2004), Dingle et al (2005) and Pyle (2015) that some populations of Monarchs in eastern areas of the PNW may migrate to Mexico for overwintering. Increased emphasis on tagging reared and wild Monarch populations in eastern parts of British Columbia, Washington, Idaho, Nevada and Utah will be a priority of continuing citizen scientist-aided research on Monarch migration in the PNW. Recent interest by penal institutions in Idaho and Nevada to offer Monarch rearing opportunities to inmates similar to the Washington State Penitentiary model may enable rapid ramping up of tagged Monarch numbers in these states.

In addition to an improved understanding of Monarch migration in the PNW, this study also contributed meaningfully to the conservation of Monarchs by adding nearly 14000 butterflies to the population over five years. Penitentiary, University and private rearing in this study achieved survival rates way above the estimated 5–10% level that occurs in wild populations (Oberhauser et al. 2015). When survival from egg to adult was recorded in the Penitentiary mass rearings, rates generally ranged between 50 and 85%. The involvement of citizen scientists in this study rearing, catching and tagging Monarchs throughout the PNW generated much community interest in the study which in turn led to greater involvement by citizens. A Facebook page was established in 2012 and now has a following of more than 3800 people <https://www.facebook.com/MonarchButterfliesInThePacificNorthwest/>. Increased awareness of Monarchs, their biology and conservation in the PNW has been an unexpected but welcome side-effect of this study.

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