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Meeting Mentoring Needs in Physical Oceanography: An Evaluation of the Impact of MPOWIR

Colleen B. Mouw

University of Rhode Island, cmouw@uri.edu

Sarah Clem

University of Rhode Island

See next page for additional authors

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Authors

Colleen B. Mouw, Sarah Clem, Sonya Legg, and Jean Stockard

1 **Meeting Mentoring Needs in Physical Oceanography:**
2 **An Evaluation of the Impact of MPOWIR**

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5 Colleen B. Mouw^{1*}, Sarah Clem², Sonya Legg³, Jean Stockard⁴

6
7 ¹Assistant Professor, University of Rhode Island, Graduate School of Oceanography,
8 Narragansett, RI, USA (ORCID: 0000-0003-2516-1882)

9 ²Marine Research Specialist, University of Rhode Island, Graduate School of Oceanography,
10 Narragansett, RI, USA

11 ³Reserach Oceanographer, Princeton University, Princeton, NJ, USA

12 ⁴Professor Emerita, University of Oregon, Eugene, OR, USA

13
14 *Corresponding author: cmouw@uri.edu, +1 (401) 874-6506
15 215 South Ferry Road, Narragansett, RI 02882

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18
19 **Abstract**

20 After a decade of program offerings, the Mentoring Physical Oceanography Women to
21 Increase Retention (MPOWIR) program initiated a community wide survey to 1) assess the impact
22 MPOWIR has had on retention of women in the field of Physical Oceanography, and 2) gauge
23 where needs are being met and where gaps still exist. To investigate the impact of MPOWIR, we
24 compare MPOWIR participants with male and female cohorts that did not participate in MPOWIR
25 but were at a similar career stage. The survey results indicate MPOWIR has had a substantial
26 impact on aiding individuals in finding and developing mentoring relationships. MPOWIR women
27 are far more likely to have a mentor and they report mentors in addition to their advisors, indicating
28 proactive seeking of mentoring relationships. Survey results indicate many unmet mentoring
29 needs for both men and women, but MPOWIR participants appear to be receiving more from their
30 mentoring relationships than their non-MPOWIR cohorts. The majority of survey respondents
31 indicated challenges to achieving their career goals, but MPOWIR participants were significantly
32 more likely to have attained their career goals, even though they had received their Ph.D. more

33 recently. 88% of survey respondents with PhDs were employed in oceanography, irrespective of
34 participation in MPOWIR. MPOWIR women indicate the program has had a large impact on their
35 lives, with the greatest impact on expansion of professional networks and exposure to professional
36 development skills. Senior participants in the program (who serve as mentors to junior scientists)
37 also reported significant professional and personal growth from being involved. Data obtained
38 independently of the survey indicate that, of the 173 women that have participated in MPOWIR,
39 the recent Ph.D.'s are predominantly in postdoctoral positions as expected, but for participants
40 receiving their Ph.D. prior to 2012, an impressive 80% are in faculty or
41 university/government/non-profit research positions. MPOWIR has therefore appeared to have an
42 important impact on retention and career satisfaction of its participants.

43
44

45 **Introduction**

46 Many of us have been fortunate at various stages of our lives to benefit from mentors who
47 have lent encouragement and opened doors of opportunity. Receiving effective mentoring can
48 increase performance, enhance motivation, build self-confidence, improve career success, promote
49 career satisfaction and growth, and improve retention (Eby et al. 2013). Research suggests that
50 mentors are particularly important for the retention of women in Science, Technology, Engineering
51 and Math (STEM): Women are much more likely to leave their field of study if they have not
52 developed meaningful mentoring relationships that help provide a sense of belonging (Dennehy
53 and Dasgupta, 2017). With this understanding of the importance of mentoring, we seek to
54 determine how well mentoring needs are being met within the field of Physical Oceanography.
55 The Mentoring Physical Oceanography Women to Increase Retention (MPOWIR,
56 <http://mpowir.org/>) program was developed 13 years ago, in response to stark gender differences
57 in physical oceanography, both in mentoring needs and representation in academic careers.

58 MPOWIR began with a workshop in October 2005 in Warrenton, VA, at which 29 physical
59 oceanographers (men and women) developed the outline of a mentoring program for early career
60 women, focusing on needs that were not currently filled by institutional mentoring or other peer
61 mentoring programs (Lozier, 2005; 2006). Prior to the workshop, a survey of physical
62 oceanographic colleagues and students at institutions and universities around the country was
63 conducted to collect information on the demographic make-up of the physical oceanographic
64 community and its mentoring needs (herein referred to as the initial community demographic
65 survey). At that time, half of the graduate students at the respondents' institutions were women,
66 but only 20% of the scientists with principal investigator status were women, and only 14% of
67 those in tenure track positions were women. A complementary study indicated the percentage of

68 women who obtained a tenured or tenure-track position dropped from 23% for those earning
69 Ph.D.'s between 1980 and 1995, to 8% for those earning Ph.D.'s between 1996 and 2009
70 (Thompson et al. 2011). The initial community demographic survey also showed important
71 differences in mentoring experiences between men and women. Whereas 24% of women said that
72 the gender of the mentor was important to them, only 12% of women had female mentors. By
73 contrast, all of the male respondents had male mentors, yet the gender of the mentor was not
74 important to the male respondents. Women were also less likely than men to have a mentor during
75 their postdoctoral years, whereas in graduate school men and women were equally likely to have
76 a mentor (Lozier et al., 2006). Based on the survey results and input from the workshop, the
77 MPOWIR program was developed with the following guiding principles (Lozier et al., 2006):

78 *The community should take collective responsibility for the mentoring of junior women.* MPOWIR
79 focuses on the collective community responsibility for mentoring, providing each junior scientist
80 with a network of mentors, to better fulfill their needs for different stages of an evolving career.

81 *The mentoring program should be designed for and by the physical oceanography community.*
82 Oceanography careers have several unique characteristics: sea time; relatively few industry jobs
83 (although growing in number); a limited number of geographical locations where jobs are
84 available; a relatively large proportion of research positions versus academic positions; a relatively
85 small discipline. Senior members of the physical oceanography community who understand the
86 culture of the discipline are best positioned to provide mentoring to junior scientists of the same
87 community.

88 *The lack of retention of junior women is a community issue, not a women's issue.* High attrition of
89 junior women after their Ph.D. creates a substantial loss of intellectual and financial capital that
90 impacts the entire community of physical oceanography. Capitalizing on the investment the

91 funding agencies and universities have made in the education of women students, and ensuring a
92 diverse workforce, requires a community effort, involving both male and female physical
93 oceanographers.

94 *Mentoring resources are best expended during the transitional years for a junior woman.* The
95 community-wide survey conducted prior to the design of MPOWIR revealed that transitions from
96 Ph.D. to postdoc and then from postdoc to entry-level positions, periods when institutional
97 mentoring programs are typically least available, were the most vulnerable times for junior women.
98 Obstacles include exclusion, lack of collaborators, lack of senior women role models, lack of
99 exposure to career development resources, and challenges balancing work and family. The survey
100 showed that only 30% of the females formed an important mentoring relationship during their
101 postdoctoral years. Thus, MPOWIR was designed to provide continuity of mentoring through the
102 early stages of a woman's career, from the final years of graduate school, through postdoctoral
103 years, to a permanent job.

104 *Effective mentoring needs many different touch points.* To accommodate the many needs of junior
105 women in a wide variety of positions at different types of workplaces (e.g., research institutions,
106 government labs, universities, industry and non-profit organizations) and at different stages in their
107 careers, mentoring should be offered in various formats, as described in the following section.

108 The MPOWIR program consists of the following elements:

109 1) **Pattullo Conference:** This biannual conference, named after June Pattullo
110 (<http://mpowir.org/resources/career-profiles/june-pattullo/>), the first woman to receive a
111 Ph.D. in physical oceanography, brings ~25 junior women physical oceanographers
112 together with 12 senior physical oceanographers for a 2.5-day meeting focused on

113 discipline-based mentoring and professional development. The senior mentors are
114 balanced between men and women.

115 2) **Mentoring groups:** Groups of ~6 junior women and 2 senior women physical
116 oceanographers meet for a monthly teleconference for the purpose of confidential, small-
117 group mentoring, where each participant can receive individualized feedback. The junior
118 women self-select into the mentoring program through open registration. The senior
119 mentors are recruited from names suggested by previous program participants and the
120 steering committee. In assigning groups, time zone is considered and care is taken to
121 ensure junior and senior participants are not from the same institution.

122 3) **NASA Speaker Series:** Each year, two junior women scientists are chosen to give a
123 seminar at a NASA lab, one at the Jet Propulsion Laboratory and one at Goddard Space
124 Flight Center, to familiarize junior physical oceanographers with the research conducted at
125 the NASA labs and to expose NASA scientists to junior scientists in the university
126 community.

127 4) **Databases and surveys:** Regular surveys are conducted to assess the effectiveness of
128 MPOWIR activities, determine community mentoring needs, and evaluate progress in
129 retention. Results of previous surveys can be found in Clem et al. (2014) and Lozier and
130 Clem (2015).

131 5) **MPOWIR website:** The website (mpowir.org) serves as a repository of resources for
132 mentoring and physical oceanography careers.

133 6) **MPOWIR webinars:** Semi-annual webinars focus on topics of particular interest to those
134 in the early stages of an independent position, provide continued support for previous

135 participants, expand gender neutral participation, and reach out to a broader scientific
136 community.

137 7) **Townhall meetings:** Townhall meetings at large conferences such as Ocean Sciences
138 provide a forum for communication and engagement with the whole oceanographic
139 community.

140 These opportunities are announced through email outreach, community listservs and social media.
141 An in-depth overview of these program elements can be found in Lozier and Clem (2015). Of the
142 opportunities listed above, the first three program elements are open to female Physical
143 Oceanographers, while the remaining elements are resources available to all fields of study,
144 genders and career stages. In 2008, the first cohort of MPOWIR women attended a Pattullo
145 Conference (Lozier, 2009; Martini et al. 2009), followed by the initiation of mentoring groups.
146 After 10 years of providing discipline-specific mentoring, MPOWIR conducted a community wide
147 survey to assess the impact to date on retention of women in the field of Physical Oceanography
148 and gauge where mentoring needs are being met and where gaps still exist.

149 **Survey Overview**

150 To assess MPOWIR's overall impact, and mentoring needs of the community, an internet-
151 based survey was open for 110 days between February 25th, 2016 and June 14th, 2016. Input was
152 solicited through email outreach, community listservs and through social media. Initial email
153 outreach distributed the survey to approximately 85 senior oceanographers, both male and female,
154 and ~245 junior women who had participated in MPOWIR in some capacity. Recipients were
155 explicitly asked to share the survey with other students and colleagues. Community listservs, such
156 as ESWN (Earth Sciences Women's Network), FAMOS (Forum for Arctic modeling and
157 observational synthesis) and the Ocean Model Working Group also served as an avenue for

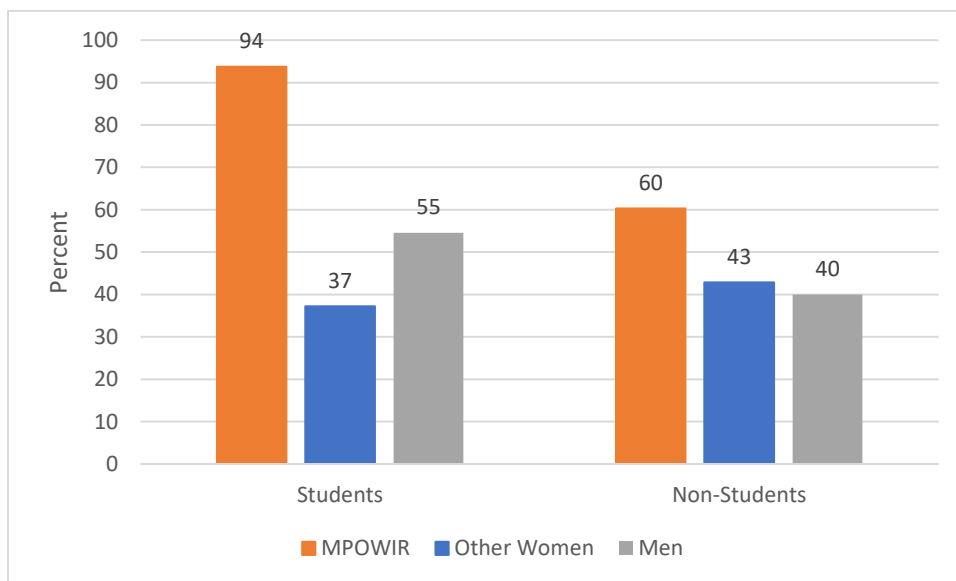
158 dissemination. Finally, social media, and in particular Twitter, aided in sharing the survey with a
159 wider audience. The major focus of this report is comparing the experiences and views of
160 participants in MPOWIR and non-participants of similar age and career stage. The analysis was
161 limited to people born after 1972, the birth year of the oldest MPOWIR participants. The sample
162 included 79 women who had participated in MPOWIR and 134 non-participants, 35 of whom
163 identified as male. All survey respondents provided input voluntarily following receipt of the
164 request for participation through one of the many dissemination channels. Results of our analysis
165 are summarized below. When we found significant differences, we report results of tests of
166 statistical significance as well as effect sizes (Cohen's d), a descriptive statistic often used by social
167 scientists to describe the magnitude of a difference between two groups. Traditionally,
168 psychologists have interpreted effect sizes of 0.20 as small, 0.50 as medium and 0.80 as large
169 (Cohen, 1988). Details on our analysis are in a supplemental file.

170 Preliminary analyses indicated that the participants and non-participants were similar on
171 important variables. There were no significant differences between the groups in age or marital
172 status (Tables 1 and 2 in the supplemental file). They also reported similar views regarding
173 professional demands of a career in oceanography and similar family-related constraints on career
174 choices (Tables 3 and 4 in the supplemental file). The MPOWIR participants were more likely
175 than other respondents to have finished their graduate work ($\chi^2 = 11.63, p = 0.001$).
176 Among those who were still in graduate school, participants and non-participants were at similar
177 stages in their schooling. But, among those who had attained their Ph.D., the MPOWIR
178 participants had finished their degrees more recently ($t = 3.10, p = 0.002, \text{Cohen's } d = .52$;
179 Supplemental Table 2). In general, these similarities between participants and non-participants
180 enhanced confidence that our targeted sampling approach produced groups that could provide

181 valid comparisons. But to ensure that the differences in degree completion did not affect our
182 findings, and because students and non-students often have different mentoring needs, we
183 examined results separately for these two groups.

184 **Having a Mentor**

185 MPOWIR participants were more likely than the other respondents to report that they
186 currently had a mentor ($t = 4.11$, $p = 0.0001$, $d = 1.06$ for students and $t = 2.07$, $p = 0.02$, $d = 0.36$
187 for non-students). Women graduate students who did not participate in MPOWIR reported
188 especially low rates of mentorship: 37% compared to 94% for their peers who had participated in
189 the program (Figure 1, Tables 5 and 6 in the supplemental file). Analyses reported below focus
190 only on respondents who had mentors (15 participants and 22 non-participants in the group of
191 students and 28 participants and 26 non-participants among non-students).

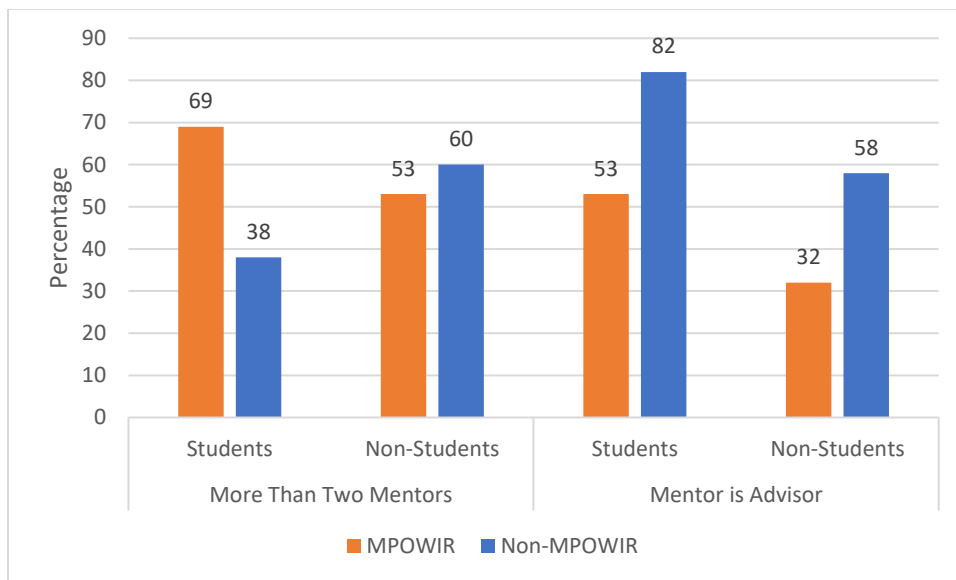


192
193 **Figure 1.** Percentage of respondents who currently have a mentor by group and student status.

194 **Mentoring Relationships**

195 MPOWIR participants were more likely than their non-participating peers to report that
196 they had multiple people they could turn to for assistance, a difference that was statistically

197 significant for graduate students ($t = 1.80$, $p = 0.04$, $d = 0.61$; see Figure 2 and Tables 7 and 8 in
 198 the supplemental file). In addition, participants less often reported that their mentor was their
 199 advisor, suggesting that their support network extended beyond formal relationships established
 200 through their schooling. This difference was statistically significant for both the student and non-
 201 student group ($t = 1.90$, $p = 0.03$, $d = 0.30$ for students and $t = 2.12$, $p = 0.02$, $d = 0.52$ for non-
 202 students; see Figure 2, also Table 9 in the supplemental file).



203
 204 **Figure 2.** Percent of respondents who have more than two mentors and whose mentor is their
 205 advisor by group and student status.

206
 207 Not surprisingly, given the gender composition of the field, men were far more likely to
 208 have the same gender as their mentor (71%), while MPOWIR women (48%) and non-MPOWIR
 209 women (43%) were equally as likely to have a mentor the same gender as themselves. In other
 210 words, there was a substantial gender difference in the probability that respondents would have a
 211 mentor of the same gender ($t = 1.79$, $df = 93$, $prob. = 0.04$; $d = 0.52$), suggesting that women tend
 212 to gravitate toward women mentors. This phenomenon had been noted in the initial community
 213 demographic survey and by other studies that suggest that the gender of the instructor or mentor

214 does not matter for males but instructors/mentors of the same gender significantly impacts the
215 engagement of females (Carrell et al., 2010). This preference for a mentor of the same gender
216 might also help account for the extraordinarily low rate of mentorship for graduate student women
217 who did not participate in MPOWIR.

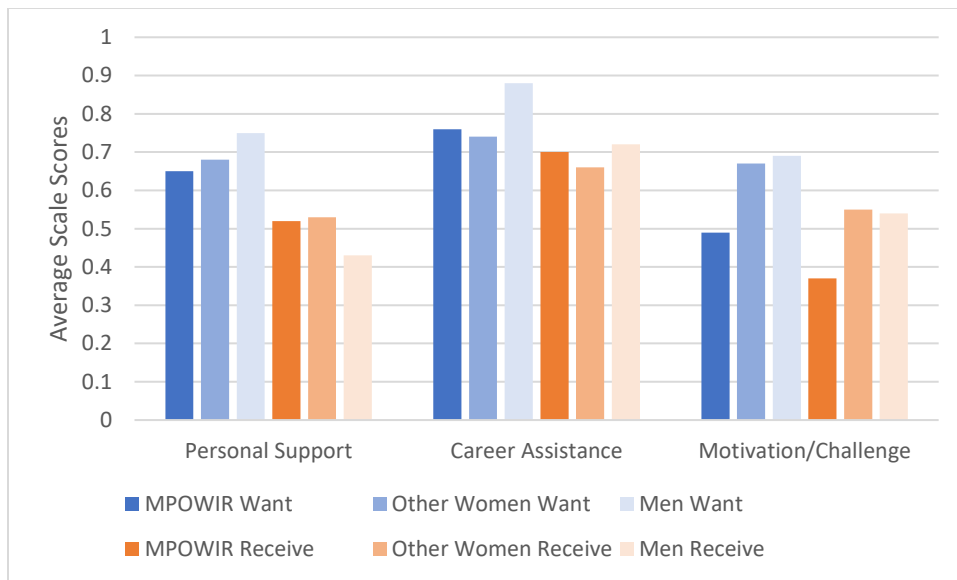
218 **Interactions with Mentors**

219 The survey also queried the nature of interactions between mentees and mentors. As would
220 be expected, graduate students more often discussed classwork and navigating graduate school,
221 while those who had completed their schooling more often talked about career issues. There were
222 no differences between MPOWIR participants and others in the topics that they discussed with
223 their mentors. The most common topics discussed were research, job applications, long-term
224 career, and family/personal issues (see Table 10 in the supplemental file).

225 In addition, a series of 19 questions asked respondents about the types of support they
226 received and wanted from their mentors. Using standard scaling techniques these responses were
227 combined into three composite variables related to the provision of 1) personal support, such as
228 listening, building confidence, teaching by example, offering encouragement, offering tools,
229 motivating, giving emotional support, and information about career paths; 2) assistance with career
230 advancement, such as coaching, providing “wise counsel,” role modeling, encouraging, assistance
231 developing professional relationships, and advocating; and 3) motivation, including items such as
232 challenging them, assisting with keeping on schedule, helping to secure funding, assisting with
233 writing, and soliciting input (see Tables 11 and 12 in the supplemental file). The MPOWIR
234 participants had significantly lower scores on the scale regarding motivation and encouragement.
235 Perhaps this is partially related to the self-selection into the program by individuals already highly
236 self-motivated who are seeking out further professional assistance from the MPOWIR program.

237 Yet these differences largely reflected the fact that the other respondents more often had mentors
 238 who were also their advisors and disappeared when this variable was controlled (see Tables 13,
 239 14, and 15 in the supplemental file).

240 Both MPOWIR and non-MPOWIR respondents reported that they wanted more support in
 241 each area than they received from their mentors. This pattern appeared with all three areas
 242 examined (Figure 3). It was somewhat smaller for the MPOWIR participants, but the differences
 243 with other groups were statistically significant with only one comparison: that for the area of
 244 personal support. Male respondents reported that they wanted more personal support than the
 245 women but received less, resulting in a gap that was more than twice that of either the MPOWIR
 246 women or the other women (Figure 3 and Table 15, in the supplemental file).



247
 248 **Figure 3.** *Mentoring want and receive factors by cohort.*

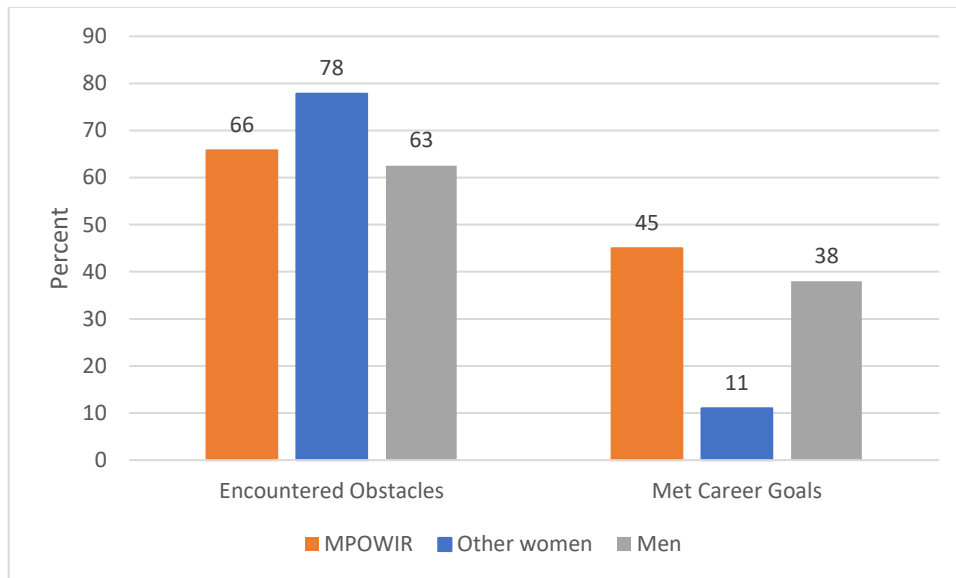
249
 250 **Progress and Challenges in Reaching Career Goals**

251 The vast majority (88%) of respondents who had finished their Ph.D.'s were employed in
 252 oceanography, and there were no significant differences in employment in the field between

253 participants and non-participants. However, this analysis just considered if respondents were
254 employed in the field of oceanography and did not assess if they were employed in their target
255 type of position for their career stage. This lack of statistical significance should be interpreted
256 cautiously due to challenges in getting the survey to participants, and non-participants no longer
257 employed in the field. This is further addressed in the following section “Other Assessment of
258 MPOWIR’s Impact,” which, we believe, provides a more accurate view of MPOWIR’s impact on
259 employment in the field.

260 About two-thirds of the respondents reported that they had met obstacles in reaching their
261 career goals, and there were also no significant differences in these reports between participants
262 and non-participants. However, the MPOWIR participants were significantly more likely than
263 non-participants to indicate that they had met their career goal ($t = 2.15$, $p = 0.02$, $d = 0.25$). This
264 may be in part be due to MPOWIR women setting more realistic and achievable goals than their
265 peers. The difference between women who had and had not participated in MPOWIR was
266 especially notable, with almost half of the MPOWIR women, but only about a tenth of the other
267 women indicating they had met this goal (See Figure 4 and Tables 17 and 18 in the supplemental
268 file).

269 Survey respondents were also asked to rank their impressions of various career challenges.
270 Even though the various cohorts reported similar rates of obstacles in pursuing their careers, the
271 MPOWIR women appear to have been more successful in facing these roadblocks. The success
272 of the MPOWIR women is striking given that they had finished their graduate work more recently
273 than the non-participants and it could be expected that they would thus be further behind in their
274 career progression.



275

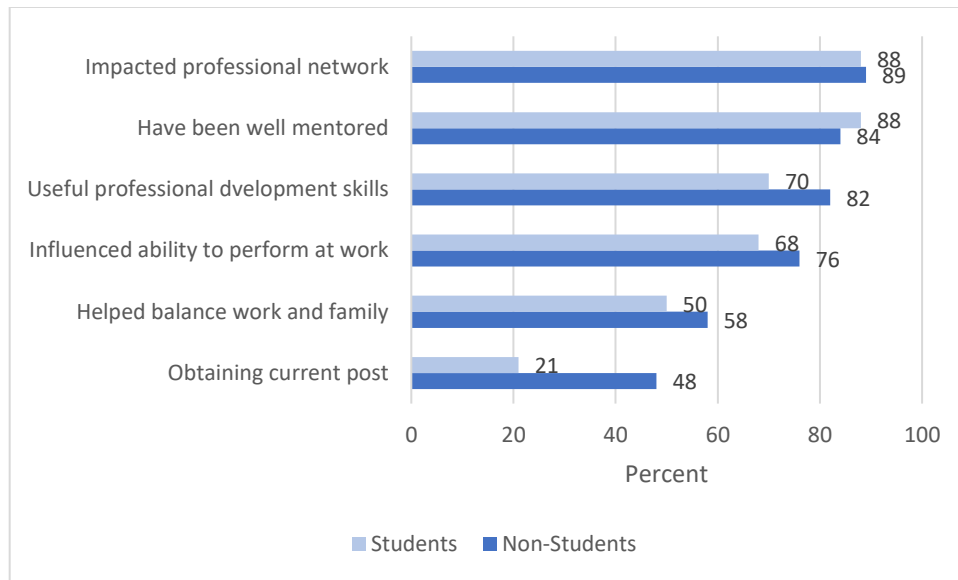
276 **Figure 4.** Encountering obstacles and reaching career goals by cohort.

277

278

279 **MPOWIR’s Impact**

280 Survey respondents who participated in MPOWIR were asked to rate the impact of
 281 MPOWIR in various career-related areas. Overall, MPOWIR women indicated the program had
 282 had a very large impact on their lives. More than four-fifths indicated that they had been well
 283 mentored via their MPOWIR connections. Similarly, high percentages indicated that MPOWIR
 284 had positively impacted (to a great extent or somewhat) their professional development skills,
 285 professional networks, and ability to perform well in their current position. Half or more of the
 286 participants indicated that the program had helped them balance work and family, while fewer,
 287 especially among the graduate students, indicated the program had helped them obtain their current
 288 position (Figure 5 and Supplemental Table 20).



289

290 **Figure 5.** Percentage of participants indicating that MPOWIR had helped them somewhat or a
 291 great deal by area and student status.

292

293 Perhaps the most valuable assessment of the impact of MPOWIR can be found in
 294 testimonies of those that have participated. A total of 35 comments were submitted by MPOWIR
 295 participants in response to the 2016 community survey, of these 34 were positive. A selection is
 296 shared here:

297 “MPOWIR has been very important for creation of peer-to-peer mentoring network, and
 298 for understanding the roots of gender bias and its manifestations in ourselves and in others
 299 and providing practical skills to gently combat bias in the workplace. Truly empowering!”

300

301 “The Pattullo conference was a really fantastic experience for me as an early-career
 302 scientist. It felt so valuable because it was the first time I felt that non-judgmental attention
 303 was focused on me. This was a great inspiration and confidence builder. Thank you!!!”

304

305 “The MPOWIR program has been one of the few resources that helped me feel connected
306 and integrated with oceanography even when the cultural conditions of my institution were
307 not inviting. MPOWIR has also helped provide a network of women advocates who
308 continue to help support me. I am incredibly grateful for this resource.”

309
310 “I really appreciate the continuity that MPOWIR provides. Though some other programs
311 exist where mentoring sessions are provided for a day to two, what stands out about
312 MPOWIR is how it actively accompanies us through the process of being an early career
313 scientist and graduating to the next step, dynamically providing tools and help to solve
314 issues/challenges as they arise.”

315
316 “The greatest benefit for me with MPOWIR has been the realization that the struggles I
317 was having were ubiquitous and experienced by very senior, well respected women in my
318 field. That, plus the networking and support have been invaluable to keep me going and
319 not give up.”

320
321 While the majority of our focus has been on the impact MPOWIR has had on the mentees,
322 information was also available from 17 senior-level women who had served as mentors. They also
323 reported significant growth from their involvement. At least half indicated that MPOWIR had
324 helped them in all areas shown in Figure 4 except obtaining their current position (Table 21 in the
325 supplemental file). Given that the mentors were primarily well established in their careers before
326 participating in the program, this result would be expected.

327 **Summary of Survey Results**

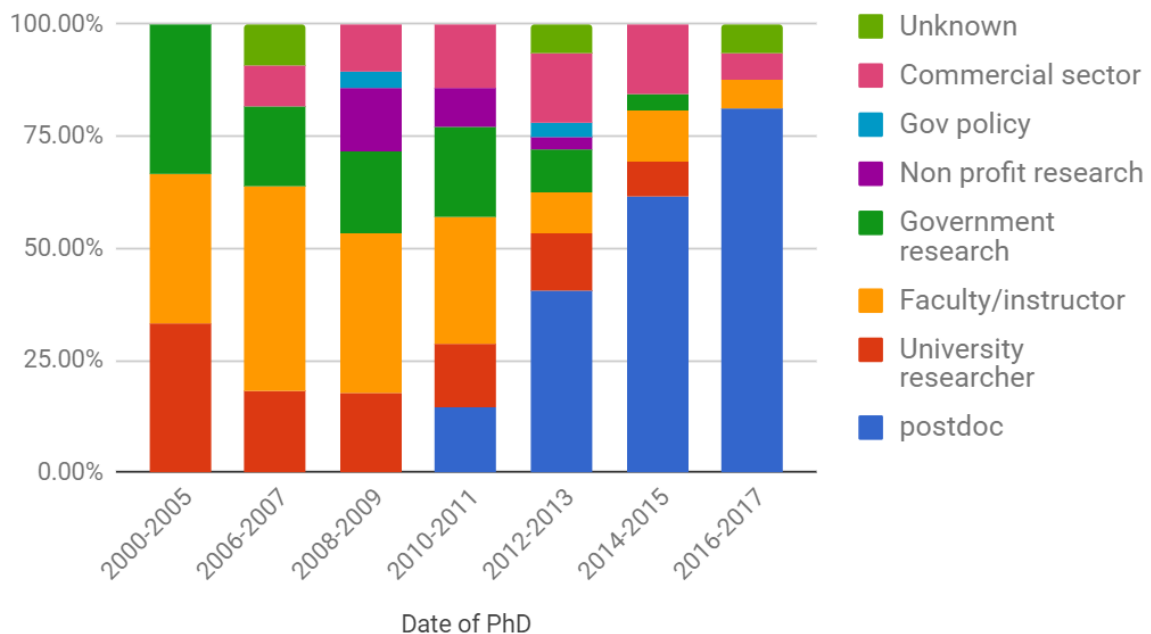
328 We believe that the results of the survey indicate that MPOWIR has been effective at
329 retaining women in the field of Physical Oceanography. MPOWIR participants were significantly
330 more likely than non-participants at similar career stages to have had a mentor. They were also
331 more likely to have multiple people that they consider mentors and to have mentors other than
332 their graduate school or post-doctoral advisors. MPOWIR participants have the opportunity to
333 engage with many mentors through various program elements and they are encouraged to
334 proactively seek mentors within their home institution and other communities they interact with.
335 While the MPOWIR participants were similar to non-participants in the topics they discuss with
336 mentors and reports of obstacles faced in their careers, the participants were significantly more
337 likely to have met their career goals. The vast majority of participants indicated that they had been
338 well mentored through the program and that it had helped them develop useful professional skills
339 and networks. In addition, those who had served as mentors reported overwhelmingly positive
340 impacts on their own careers from their participation.

341 **Other Assessments of MPOWIR's Impact**

342 In addition to the community survey reported above, another method of evaluating the
343 impact of MPOWIR on retention and career progression is to track the careers of individual
344 MPOWIR participants. To avoid the complications of response rate and self-reporting biases
345 associated with surveys, we have sought to determine the current career status of all past MPOWIR
346 participants using web search tools, combined with our information on the last verified email
347 address of the participant. We were able to determine the current career status of all but nine of
348 our 173 MPOWIR participants as of May 2017. Of those 173 participants, 154 have completed
349 their Ph.D.'s, with the remaining 11% either currently enrolled as students or unknown. (Note that
350 the different ratio of students to non-students compared to the survey reflects the fact that here we

351 are attempting to track all participants from the decade-long program, whereas survey respondents
 352 may be biased toward those with more recent involvement, and the survey was completed before
 353 the tracking of participants was completed). Career status is shown as a function of date of Ph.D.
 354 in Figure 6. Recent Ph.D.'s are predominantly in postdoc positions, as expected, but for
 355 participants receiving their Ph.D. prior to 2012, an impressive 80% are in faculty or
 356 university/government/non-profit research positions. In particular, we highlight that for those
 357 receiving Ph.D.'s between 2006-2011, 34% are in faculty or instructor academic positions.
 358 Approximately 15% are in commercial sector positions, including for-profit oceanography/climate
 359 companies (e.g. Sea-bird Scientific, the Climate Corporation), or technical jobs at companies such
 360 as Facebook and Bank of America. On average, 5% are unknown, suggesting they have left the
 361 field. Compared to average loss rates of ~30% of women who have earned Ph.D.'s in STEM fields
 362 (Shen, 2013), these statistics indicate that MPOWIR is successfully reducing the loss of Physical
 363 Oceanographers from the field, as well as promoting participants into prominent academic and
 364 research positions.

365



366

367 **Figure 6.** The current employment of past MPOWIR participants, shown as a function of date of
368 Ph.D., and as a percentage of the total Ph.D.'s by date.

369
370 Another quantitative method to assess MPOWIR's impact is examining the demographics
371 of Physical Oceanographers in permanent positions in U.S. institutions. Prior to the initiation of
372 MPOWR in 2007, the initial community demographic survey assessed the number of male and
373 female faculty in academic and research positions at various career levels in oceanography
374 departments in thirteen universities and government labs across the U.S. This survey highlighted
375 the need to improve the retention of women, with less than 18% of faculty being female, far fewer
376 than the percentage of Ph.D.'s awarded to women in Physical Oceanography (Table 1). Ten years
377 later, MPOWIR revisited this assessment to see if overall improvement occurred with the existence
378 of a community mentoring program. In 2017, in the same thirteen universities and laboratories,
379 26% of the physical oceanography faculty are female. Even greater improvements are seen in the
380 percentages of women in associate and full professor positions as compared to 2007 (Table 1).
381 This increase in the percentage of women is encouraging, but improvement has not been uniform
382 across institutions.

383 There is a stark difference between Physical Oceanography and Chemical Oceanography
384 in the occupation of women in Assistant and Associate ranks. In Physical Oceanography, there
385 are nearly equal occupation of women at the Assistant and Associate ranks. However, in Chemical
386 Oceanography, the percentage of women at the Assistant level is nearly equal to that of Physical
387 Oceanography, but is about half at the Associate level. It is clear that MPOWIR has improved
388 retention for its target community of Physical Oceanography. While MPOWIR's target is women
389 in the last two years of graduate school through the attainment of the first permanent position, it
390 seems that the culture of proactive mentoring that MPOWIR promotes is continued with these
391 women into their permanent jobs. The women who had participated in MPOWIR's programs but

392 had progressed in their career beyond the stage of targeted by MPOWIR, voiced an interest and
 393 need for some level of continued mentoring. In response, MPOWIR added the webinar series (see
 394 the introduction) to its programming in 2017. The webinars are open to any field, career stage and
 395 gender.

396
 397 **Table 1.** Percentage of women at each faculty level as
 398 compared with total of males and females in each sub-
 399 category. Chemical oceanography is used as a control as
 400 no similar mentoring program exists for that community.

	2007 Physical Oceanography	2017 Physical Oceanography	2017 Chemical Oceanography
Assistant	36%	39%	43%
Associate	19%	35%	26%
Full	10%	19%	21%
Total Percent Female	18%	26%	26%

411
 412
 413 **Outlook**

414 Since 2009, women have surpassed men in the number of Ph.D.'s earned in Ocean Sciences
 415 (Bernard and Cooperdock, 2018). Within Physical Oceanography, between 2001- 2012, 35% of
 416 Ph.D.'s in were earned by women, and as of 2017, 26% of faculty positions in Physical
 417 Oceanography were filled by women, up from 18%, ten years earlier. Similar improvements are
 418 seen across all of geoscience with an increase in female geoscience faculty from 16% in 2006 to
 419 23% in 2016 (Wilson, 2017). With the improvement in gender ratios at academic and research
 420 institutions, combined with the impressive 80% of the MPOWIR participants who received a Ph.D.
 421 prior to 2012 now holding permanent positions in the field, the evidence suggests that MPOWIR
 422 is improving the climate and retention rate for women beyond those women directly participating

423 in MPOWIR. MPOWIR is uniquely situated to offer confidential mentoring, independent of
424 academic institution, which supports junior women Physical Oceanographers through the career
425 transitions from Ph.D., through post-doc, to permanent positions, as well as within-discipline
426 networking, which are not duplicated by institutionally-based programs or large open peer
427 networks.

428 With the success reported here, our opinion is that progress is far from complete. The
429 gender ratio in faculty level positions is still not equal to that of the students in the same program.
430 Gender bias in hiring and mentoring in academia still exists, as shown by numerous recent social
431 science experiments (Moss-Racusin et al, 2012, Sheltzer and Smith, 2014). Women continue to
432 be overlooked as reviewers (Lerback and Hanson, 2017), invited speakers (Casadevall and
433 Handelsman, 2014), and award recipients (Mervis, 2017). The increasing discussions about sexual
434 harassment and bullying in science (Feder, 2016; Hollis, 2012) demonstrate the need for
435 confidential discussion spaces (such as provided by the MPOWIR mentoring groups) for early
436 career women scientists. MPOWIR cannot, by itself, change the culture of science, but we provide
437 the support needed to help overcome these obstacles and raise awareness of these issues among
438 senior scientists participating in our programs. Relationships built through MPOWIR foster an
439 increased sense of belonging in the oceanographic community which, in turn, encourages
440 participants to continue with oceanographic careers. Continual increases in demand for mentor
441 groups and the Pattullo Conference provide evidence of MPOWIR's value to the community.

442 While these results are encouraging, we emphasize that we have only highlighted the
443 significant results from the survey. Although there was no indication of negative results related to
444 MPOWIR many of the comparisons did not lead to significant findings, which may be due to the
445 small sample sizes. We also recognize that the self-selection of MPOWIR participants may bias

446 the participants toward those who are more motivated to succeed. Regular thorough examination
447 of gender equity would help to provide more reliable insights. Further documenting institutions
448 that are excelling and struggling in equity and investigating the reasons for success could help
449 develop policies and rewards to promote equity.

450 MPOWIR is far from the only program aimed at increasing retention of women in STEM
451 careers. Other programs include the NSF-funded ADVANCE program (*Increasing the*
452 *Participation and Advancement of Women in Academic Science and Engineering Careers*) which
453 aims to improve gender equity in STEM academic positions through institutional transformation;
454 the Earth Science Women's Network (ESWN, <https://eswnonline.org/>), which provides peer-
455 mentoring and career development support to more than 3,000 women in geosciences worldwide;
456 the Society for Women in Marine Science (SWMS, <http://swmsmarinescience.com/>) which brings
457 together marine scientists of all career levels to celebrate and promote the research done by women
458 in marine science; and mentoring programs in individual academic institutions and departments.
459 These programs are all complementary, using different approaches and tackling different aspects
460 of the challenge of increasing gender parity in science.

461 We have been able to demonstrate the impact that MPOWIR has had on the demographic
462 it targets. However, through comments at our townhall events, personal conversations, and
463 evidence from this survey, it is clear that there are significant unmet needs for thoughtful, persistent
464 mentoring across many disciplines, genders, identities and career stages. Previous research has
465 indicated conceptualizations of the ideal mentor vary by age, gender, and citizenship, but not by
466 academic discipline or stage of persistence (Rose et al. 2005). Thus, while MPOWIR's focus is
467 on women in Physical Oceanography, we hope that MPOWIR's impact has been broader than just
468 its target demographic through our program elements that are open to everyone (townhalls,

469 webinars, online resources; <http://mpowir.org/>) and we encourage those outside our target
470 audience to participate. We hope the success that MPOWIR has demonstrated aids other groups
471 and disciplines to develop targeted mentoring programs for their communities. To assist with
472 translating MPOWIR's program elements to other communities, a handbook has been developed
473 that outlines programmatic and logistical considerations for all of MPOWIR's program elements
474 (Clem et al. 2016).

475 The need for mentoring goes beyond women. Our survey results also indicated many
476 unmet mentoring needs for men at the same career stages as the women who have participated in
477 MPOWIR. The community as a whole, could benefit from mentoring training with sensitivity
478 toward all identities and regular surveys of the state of the profession with regards to a variety of
479 equity issues. We therefore encourage all members of the oceanographic community to appreciate
480 the importance of mentoring for all their colleagues. All institutions should encourage and reward
481 good mentoring in addition to research achievement in their hiring and promotion practices.

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