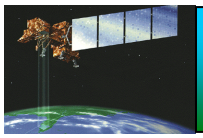


Chapter 6
Institutionalization of GI/GIT in State Forestry Organizations

This chapter provides information about how the nation's SFOs incorporate, manage and deploy remote sensing and other GIT within their organizations. Findings also include attention to geographic information (GI) when these data matters are addressed in addition to technology. This broad theme includes understanding the organizational approach and structure, leadership roles, types and distribution of data and technology roles and responsibilities, types of staff and contacts, internal and external coordination and relationships, and GIT policies, plans, issues, and benefits. Information presented in this chapter draws on sections 1 and 3 of the "State Profiles" in Appendix C.

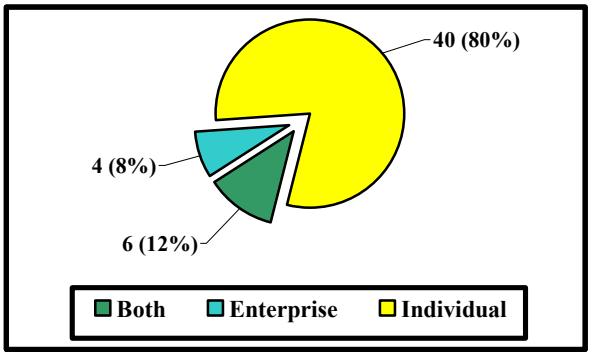
Literature on implementation of GIT in public sector agencies and information systems in private companies points to organizational, management and other institutional factors as the keys to successful applications at all levels within organizations, including operational, management, and strategic levels (Budic and Godschalk 1994, Khosrowpour 1994, Huxhold and Levinsohn 1995, Reeve and Petch 1999). The analysis presented below shows that SFOs have various approaches and levels of policy and management support. Institutional GIT implementation practices range from fragmented and ad hoc to enterprise approaches enabled by policy and planning guidance, dedicated staff and other resources and training. Consequently, the issues and benefits reported by the SFOs are equally diverse.

6.1 Organizational Approaches

Introduction of computerized GIT into an organizational environment is a complex process of mutual adaptation between the two. The experience and research accumulated over several decades show that the difficulties associated with introduction of GIT in public organizations are primarily due to the complex and idiosyncratic nature of organizations and adopters of new technology. Taking a specific organizational approach is aimed at establishing an optimal fit between the organization and the technology that will promote the most effective use and applications (Nedovic-Budic 1995).

A typical forestry organization has three management levels based on geographic areas that range from the smallest (area or field) up to the regional level, and then up to the headquarters or central level which typically address all forested or other lands within a state's borders (Smith and Prisley 1991). GIT may be integrated within all three levels and across virtually all program missions within a SFO. This approach is commonly referred to as an enterprise approach, which is characterized by being comprehensive and distributed. The opposite of this approach is an individual approach, which assumes that management levels and program units within an SFO work independently in terms of GIT, and primarily on a project basis. Several SFOs report that they have both an enterprise and individual approach, meaning that GIT is integrated and coordinated for some of the programs and functionality. As shown in **Figure 6-1**, the majority of SFOs (40 or 80%) use GIT to accomplish individual program missions or for individual projects. Comprehensive, enterprise approaches to geographic information and/or GIT are rarely utilized. Only one fifth of the states (10) have deployed an enterprise approach, either for a portion of their organizational functions

Figure 6-1. GIT Organization Approach



(by combining the enterprise with an individual approach) or to encompass and integrate all SFO functions that can use GIT. Only four of the SFOs have an enterprise approach, while six have both an individual and enterprise approach in their use of GIT. For example, the Idaho Department of Lands (IDL), starting in the mid 1970s, has been implementing GIT as one component of an integrated management approach to overall departmental data. The GIS/Cartography Section staff provides support in IDL's headquarters and 14 field offices. Data distribution among IDL offices was previously handled via CD ROM, and is being replaced by a wide area network (WAN).

While the majority of SFOs do not have an enterprise approach, this finding does not necessarily mean that SFOs lack management attention to GIT activities and issues. Regardless of the type of organizational approach (enterprise or individual), many SFOs (39 or 78%) coordinate their GIT activities internally. This is evidenced by their recognition of internal focal points, either designated formally or informally, as indicated in **Figure 6-2**. More than half (22) of those internal focal points are individual full time or part time GIT personnel. In addition, about one fifth (7) of the SFOs have dedicated GIT units or program units with broader roles that include central GIT responsibilities within their scope of work. Those lead units have responsibilities broader than GIT, but provide strong technological, data, and staffing support to their SFOs. For example, as described in each applicable SFO profile:

- The Fire and Resource Assessment Program (FRAP) is responsible for GIS implementation within the California Department of Forestry and Fire (CDF).

- The Planning and Information Services Section in the Hawaii Division of Forestry and Wildlife (DOFAW) provides GIS services, and determines and implements GIT policy, such as identifying and prioritizing data creation projects, securing funding for data collection and providing training and technical support.

- The Information Technology Section of the Pennsylvania Bureau of Forestry's Operations and Recreation Division supports Bureau-wide GIT hardware and software installation and operating systems support.

- The Information Technology Division of Washington's Department of Natural Resources provides overall data management and technical expertise, including for GI/GIT.

Figure 6-2. GIT Coordination Entities within State Forestry Organizations

	Frequency	Percent	Cumulative Percent
Internal Focal Point	39	78%	100%
Parental Focal Point	1	2%	2%
Fragmented	10	20%	22%
Full Time GIT Person	15	30%	30%
Part Time GIT Person	7	14%	44%
Lead Unit with GIT	4	8%	52%
GIT Unit	3	6%	58%
Other	10	20%	78%
N/A	11	22%	100%
Total	50	100%	

A feature common to all these organizational units is the presence of dedicated GIT staff that conduct work to meet enterprise needs and sometimes provide assistance to specific mission areas within the SFO.

SFOs without an internal focal point (11) are classified as either fragmented in their implementation of GIT (10 or 20%), or in one case, specifically assisted by their parent in efforts to coordinate internal GIT activities. Not coincidently, however; all ten SFOs with fragmented GIT internal coordination are also characterized by an individual approach. In those organizations, GIT is applied on an ad hoc basis, with very little effort to coordinate internally and to relate to other users and data resources within their SFO.

An important issue is whether one organizational approach is better than others, and if these approaches have an impact on the use of each or all three forms of GIT. Relevance of the organizational approach as reflected in the level of GIT use is presented in **Figure 6-3**. The level of GIT presence in each of the SFOs, as described in Chapter 4 (i.e., limited, medium, active, and advanced), is cross-tabulated with three types of organizational approaches taken by SFOs as described above, including individual, enterprise or a combination of both approaches. The results clearly show that the enterprise approach is associated with higher presence of GIT. Nine out of 10 SFOs that have enterprise or both (enterprise and individual) approaches are either active or advanced in their GIT use. Individual approaches are almost exclusively associated with more limited GIT use. The 40 SFOs with this approach are almost evenly split between low and high GIT users. However, there is no advanced GIT user among them. The relationship between the level of GIT presence and organizational approach is statistically significant for the levels of GPS and RS use, but non-significant for GIS. One possible explanation regarding the GIS presence is that the more pervasive nature of GIS and relatively more mature applications in most SFOs may contribute to the level of GIS use being less dependent on the organizational approach.

Figure 6-3. GIT Presence and Organizational Approach

	Both	Enterprise	Individual	Total
Limited	0	0	7	7
Medium	1	0	14	15
Active	2	3	19	24
Advanced	3	1	0	4
Low*	1	0	21	22
High*	5	4	19	28
Total	6	4	40	50

*Low = Limited or Medium; High = Active or Advanced
**Pearson Chi-Square significant at 0.001 level for GIT 4-level variable (limited, medium, active & advanced); 0.047 level for GIT 2-level (low-high) variable

A completely independent approach to GIT rarely exists in SFOs or other organizations. Once other GIT users within and outside an organization become known, the benefits associated with cooperation often become recognized, particularly in terms of data sharing. Cooperation allows organizations to draw on each other's strengths and capacities, and enables resources to be preserved for alternative purposes. SFOs are no exception to this. **Figure 6-4** shows that more than half of the SFOs (31 or 62%) receive some or extensive assistance from other organizations, which can increase their capability to handle GI and apply GIT more effectively. Sources of assistance are split between parent agencies, other outside agencies, and mixed sources, many of which include parent organizations. The total number of SFOs that receive assistance from their parents alone (11) or from parents in combination with other organizations (seven) is 18 (or 36% of all SFOs). SFOs with extensive support have parental organizations in environment and natural resources (11), in agriculture (two), or have no parent (three).

Figure 6-4. Sources of GIT Assistance in SFOs

	Frequency	Percent
Extensive	**16**	**32%**
Some	**15**	**30%**
None	**19**	**38%**
Parent Alone	**11**	**22%**
Outside	**9**	**18%**
Mixed	**11**	**22%**
None	**19**	**38%**
Parent, and with Others	**18**	**36%**
USFS	**3**	**6%**
Federal - Other	**2**	**4%**
State GI/GIT Coordinator	**4**	**8%**
State - Other	**6**	**12%**
University	**10**	**20%**
Other	**5**	**10%**

The two variables are cross-tabulated to determine if GIT assistance is associated with the level of GIT use. No apparent pattern exists between the level of GIT presence or for any of the three technologies and the level or source of GIT assistance. This means that the recipients of assistance are SFOs with well-established GIT installations and the less active GIT users alike. As stated above, GIT assistance is a form of overall cooperation and mutual support. Assistance is needed for other reasons in addition to GIT initiation. A borderline statistical significance (0.053) is found on the relationship between the level of GIS use and assistance from parent organizations. On average, SFOs that receive assistance from parent organizations are more likely to be limited in their use of GIT. This relationship suggests that parent organizations tend to be the more frequent source of support for SFOs that are in an early stage of GIS implementation than other types of supporting organizations.

In summary, organizational approaches vary substantially among the SFOs. Many organizations pursue an individual approach to GIT development and use, but also receive assistance from their parents, outside agencies, or a mix of sources. The assistance does not characterize only the SFOs in the early stage of GIT implementation and use, but reflects more broadly configured cooperation practices among agencies that are organizationally and physically near each SFO. Enterprise approaches that are comprehensive, distributed, and integrated only exist in a minority of states, but the value of such approaches is recognized by multiple or several SFOs. Enterprise approaches coincide with higher level of GIT usage, and many SFOs are transitioning to adopt these approaches. Development of a distributed approach is necessary for diffusing the GIT capabilities and use throughout an organization, and to field offices in particular (Bettinger 1999, Reed 1991).

6.2 GIT Staffing, Other Users, and Contacts

Successful implementation of GIT in public sector agencies depends largely on how the individual organizational members accept and utilize the technology. Provision of staff support and achieving a critical mass of users is essential for effective implementation of GIT in an organization (Nedovic-Budic and Godschalk 1996; Nedovic-Budic 1998) and is a crucial component of GIT institutionalization. This area of concern is generally referred to as human factors and resources, and addresses the issues of technical and analytical expertise, training, and the level of acceptance of technology necessary for the development of a wide and active user base. Human factors and resources present greater obstacles to information system implementation than the technology itself. The profiles in Appendix C reveal that even SFOs with dedicated and substantial staff resources express that trained personnel with expertise are

a continuous challenge, such as those in Alabama, Alaska, Illinois, Nevada, Oregon, Utah, and Wisconsin.

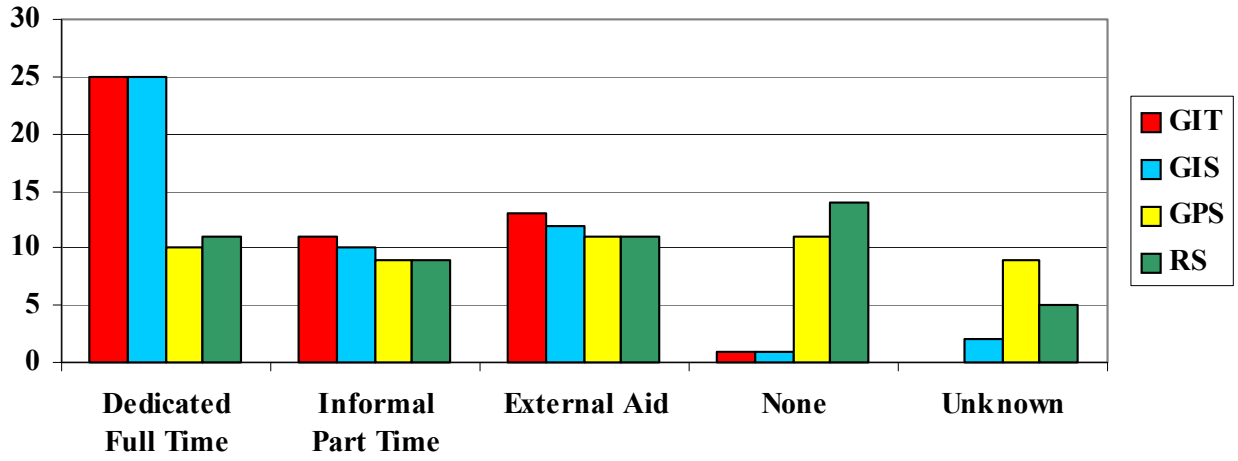
As discussed above, the organizational nature of SFOs and deployment of GIT within many of them has resulted in distributed approaches in which GIT participants include staff in headquarters, staff in field/regional offices, and other GIT users. As a result, investigation about internal GIT staffing within SFOs requires differentiation between staffing in headquarters, users in field/regional offices, and other GIT users. As illustrated in **Figure 6-5**, the number of GIT staff and users varies considerably across the SFOs. Mean (average) values are substantially higher for users in field/regional offices than for headquarters staff. The averages are skewed by several heavy users of GIT in the field/regional offices, such as Alabama for GPS, Maryland for GIS, and Pennsylvania for all three forms of GIT. They are also affected by missing information for many SFOs, resulting in sample size as small as 13 for GPS staff support in headquarters.

Minimum staffing in headquarters is categorized as: dedicated full time, dedicated part time, informal full time, informal part time, other internal, and external aid staff. In cases when a particular technology is not employed, information about staffing is recorded as not applicable. As shown in **Figure 6-6**, the majority of the dedicated, informal part time, and external staff support is for GIS, with half of the SFOs having at least one full time dedicated GIS person. In addition, about one fifth of the SFOs have a dedicated staff working with GPS or RS. The number of informal part time staff in GIS, GPS, and RS is about equal to the number of external aid staff. These findings are generally driven by SFOs that have substantially higher numbers of dedicated staff than the average SFO, including those in the states of California, Idaho, Oregon, and Washington. Their dedicated staff accounts for one half of all dedicated GIT staff in all SFOs. Full information about distribution of GIT staff across GIS, GPS, and RS fields could be derived only from a small number of state profiles.

Figure 6-5. GIT Staffing Support and Users in Headquarters and Field/Regional Offices

	N	Range	Minimum	Maximum	Sum	Mean
GIT Staff – Headquarters	35	30	0	30	106.1	3.03
GIT External Aid to HQ	23	1	0	1	5	0.22
GIS Staff – Headquarters	20	7	0	7	37.5	1.88
GIS External Aid to HQ	20	1	0	1	4	0.20
GPS Staff – Headquarters	13	1	0	1	2	0.15
GPS External Aid to HQ	18	1	0	1	1	0.06
RS Staff – Headquarters	14	0	0	0	0	0.00
RS External Aid to HQ	18	1	0	1	1	0.06
GIT Users	21	40	0	40	82.5	3.93
Field/Regional GIT Users	19	235	0	235	385	20.26
Field/Regional GIS Users	15	74	0	74	177	11.80
Field/Regional GPS Users	10	80	0	80	147	14.70
Field/Regional RS Users	15	100	0	100	100	6.67

Figure 6-6. Minimum Staffing Support in Headquarters by Type



External staff provides valuable support to existing internal staff and users. **Figure 6-7** reveals that over half of the SFOs indicate that data and application developments are supported by staff from other private and public sector agencies and universities in addition to internal staff. The types of external aid staff include: dedicated full time staff, informal part time staff, other, and none. Most of the external aid staff is informal part time, with only a small portion of dedicated full time staff aid (about one tenth of the number of part time staff). External aid staff exists primarily in the SFOs that receive outside assistance. All 31 SFOs that are either somewhat or extensively assisted by another organization have external aid staff, with three SFOs having dedicated GIT staff and the remainder (28) having part time staff assistance. This relationship is tested by the Pearson Chi-square test, and is highly statistically significant (below 0.000 level). This result affirms that staff support is an important form of general GIT assistance.

Figure 6-7. Minimum External Staffing Support in Headquarters by Type (N = 50 = 100%)

	GIT		GIS		GPS		RS	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Dedicated Full Time	3	6%	3	6%	1	2%	0	0%
Informal Part Time	28	56%	28	56%	23	46%	28	56%
None	18	36%	17	34%	17	34%	17	34%
Unknown	1	2%	2	4%	9	18%	5	10%

Field/regional offices are also quite diverse in the type of staff working with GIT. Adoption of GIT by the field staff is of ultimate importance for the effective use of GIT in forestry applications (Kokoshke 1991). Field/regional office staff need the technology primarily for data collection (inventories), maintenance, and operations management. Decision-making, resource allocation, and policy development are also relevant uses of GIT for the field/regional staff. As suggested in **Figure 6-8**, GIT penetration in field/regional offices is notable in 60 to 80% of SFOs, and is quite advanced in several of them. Those organizations invest a major effort in providing consistent training and in adopting procedural innovations, in order to fully incorporate GIT in performing daily and strategic organizational missions.

The following examples illustrate how GIT can be implemented in field/regional offices:

- In Maine, all nine Ranger Districts in Forest Protection, six foresters in Forest Policy and Management, and one entomologist in Forest Health and Monitoring have ArcView licenses; and all field staff either has or has access to a GPS receiver.
- In Minnesota, central and regional office GIT use is enhanced by the acquisition of laptop docking stations that allow staff increased access to data in the field.
- The Alabama Forestry Commission's aircraft are equipped with GPS units, and it recently purchased GPS units for each of its 67 county offices.
- Arizona's Fire Management Division has 23 staff people that use GIT on a part time basis, which is primarily GPS use at this time.
- In Maryland, the Forest Service's GIS Geomatics Lab provides support to 74 GIS/GPS users and GIS data developers throughout the Service's four regions, as well as those stationed at headquarters.
- Pennsylvania is making significant contributions toward GIT implementation with its Bureau of Forestry field office staff of over 55 GIS users, over 80 GPS users, over 90 aerial photography users, and over ten satellite imagery users. In addition, all field staffs are trained in ArcView ™ 3.2 and GPS use.

Figure 6-8. Staffing Support in Field/Regional Offices by Type (N = 50 = 100%)

	GIT		GIS		GPS		RS	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Dedicated	3	6%	3	6%	0	0%	1	2%
Informal	40	80%	38	76%	31	62%	29	58%
External	2	4%	2	4%	2	4%	2	4%
None	5	10%	5	10%	8	16%	14	28%
Unknown	0	0%	2	4%	9	18%	4	8%

Informal part time users of GIS, GPS and RS are in the majority in field/regional offices. Those users are specialized in various aspects of forest management and use GIT in conjunction with other program responsibilities. Thus, having very few of the field/regional staff as dedicated full time is quite justified. For example, in New York, about 25-30 regional staff use GIT, with five to six of these staff using it about 25% of the time and the remainder using it less than 10% of the time. In Pennsylvania, most of these field staff devote 10-25% of their time for GIT activities. In Minnesota, the majority of SFO staff employ GIT on a regular basis as a tool in their daily activities.

To examine the impact of staff support on GIT use, the categories of GIT presence in each of the SFOs (as described in Chapter 4), are compared to the level of staff support in both headquarters and field/regional offices. Results of cross-tabulation presented in **Figure 6-9** confirm with high statistical significance that such support is important in achieving advanced use of GIT. Presence of dedicated full time staff is particularly important for promoting and ensuring GIT use. The pattern with field/regional staff support is less obvious, but still indicates that more staff support is associated with higher levels of GIT use. Similarly significant results apply to GIS, GPS, and RS. Of the 20 SFOs that have dedicated full-time GIS staff, 16 (80%) are categorized as advanced users. In the case of field/regional offices, the data suggest that informal part-time staff provide the support needed for higher level of technological applications. This finding is consistent with the discussion about the nature of GIT users in field/regional offices. For most of the staff, GIT is a tool for conducting their specialized activities. Thus in field/regional offices, a wide user base, particularly among staff with variety of other responsibilities, is possibly more important than the full time devotion of a fewer number of GIT experts.

6-9. GIT Presence and Staff Support

Headquarters					
	Dedicated Full Time	Informal Part Time	External Aid	None	Total
Low	4	6	11	1	22
High	21	5	2	0	28
Total	25	11	13	1	50
Field/Regional					
Low	0	17	0	5	22
High	3	23	2	0	28
Total	3	40	2	5	50

*Low = Low or Medium; High = Active or Advanced
**Pearson Chi-Square significant at 0.000 level for staff support in headquarters; 0.003 level for staff support in field/regional offices

Further contingency analyses reveal other aspects of staff support. Statistical significance tests indicate that only SFOs with dedicated full-time GIT staff have taken an enterprise approach. These tests also reveal that all SFOs with internal coordination focal points have dedicated full-time staff; and SFOs with dedicated full-time staff are less likely to seek assistance from the parent or other organizations (although having dedicated staff does not fully exclude having such a relationship). Correlation analyses presented in **Figure 6-10** indicate statistically significant associations between the number of GIT staff in headquarters and the number of GIT users, management expenditures in absolute and relative terms (i.e., total and per acre of state owned forested land), total funding, and management and professional personnel.

The number of GIT users relates significantly to the overall personnel numbers, and professional personnel in particular. There is no significant relationship found between staff support and the level of use of any of the three individual technological types (GIS, GPS, and RS), primarily due to limited information. There is also no significant relationship between staff support and total amount of forested or state-owned forested land, or with demographic indicators of population size, change, and density. Financial capacity and the overall professional environment seem to exert most influence on the level of GIT staffing and extent of the user base. Presence of GIT staff at headquarters offices seems particularly important in facilitating diffusion of GIT to users across the SFOs.

6-10. Correlation of GIT Staffing in Headquarters and GIT Users with Financial and Personnel Variables

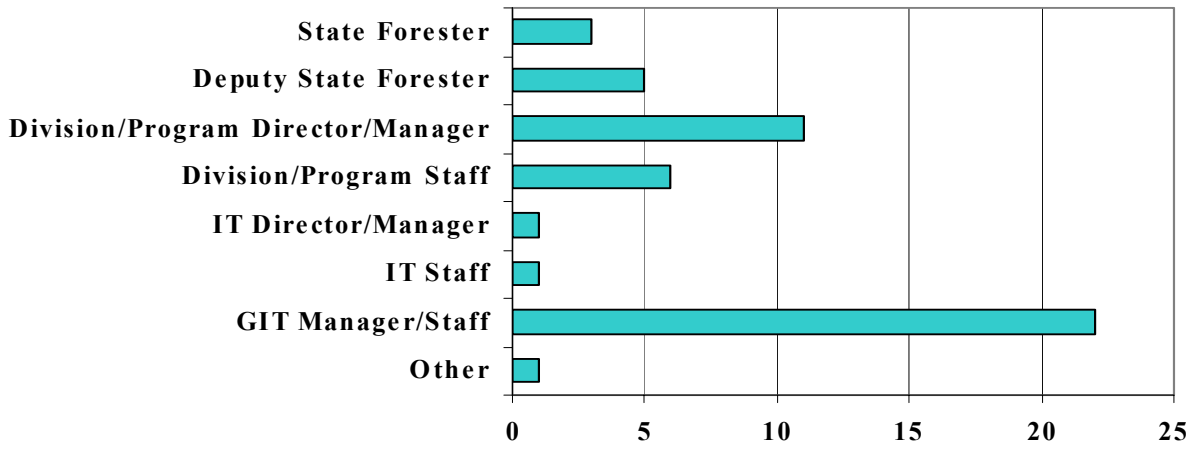
	HQ GIT Staff			GIT Users		
	Pearson Correlation	Significance (2-tailed)	N	Pearson Correlation	Significance (2-tailed)	N
GIT Users – Number	0.609	0.021	14			
Management Expenditures for State Owned Forests (Millions $ / Acre)	0.558	0.001	31			
Management Expenditures (Millions $)	0.819	0.000	31			
Funding – Total (Millions $)	0.439	0.009	34			
Professional Personnel – Number	0.770	0.000	34	0.720	0.000	20
Professional/Management Personnel – Number	0.728	0.000	34	0.656	0.002	20
Technical Personnel – Number				0.603	0.005	20
Personnel – Total Number				0.626	0.003	20
Personnel – Number / Acre of Forested Land				0.564	0.010	20

In addition to specialized staffing and users, SFOs have other personnel involved in the management of GIT. Key organizational GIT contacts are important players in the overall organizational infrastructure that supports GIT applications. GIT managers and staff serve as these key contacts in almost half of the SFOs (22 or 44%), as presented in **Figures 6-11**. A variety of other types of employees have this responsibility for being a communication point for GIT. In the order of how frequently they are present in the remaining 28 SFOs, those members are: division/program director/manager; division/program staff; deputy state forester; state forester; information technology director/manager; information technology staff; and other.

The key contacts take a wide range of responsibilities. In 27 (54%) of the SFOs, the key contacts have a significant GIT role. Higher numbers of staff with GIT responsibilities than the number of GIT managers/staff who serve as key contacts suggests that there are non-GIT staff who are in charge of some aspect of GIT. Of the 27 contacts that are identified as having GIT responsibility, 21 are involved as analysts, 14 address technical issues, 13 have managerial duties and seven of them deal with other tasks. The sum of GIT-related responsibilities is higher than 27 because GIT contact persons have multiple roles regarding GIT. For instance, a GIT person may serve as an analyst, but also provide management support. Only four key contact staff have only management responsibility. This practice reflects a general lack of understanding about the significance and need for focused management of information resources and of the GIT implementation process (Budic and Godscahlk 1994; Huxhold and Levinsohn 1995). Introduction and transfer of new technology is a complex task that requires careful planning and management activities. With implementation of GIT in headquarters as an initial challenge, shifting functions from a central office to regional offices can also be plagued with obstacles. Bettinger (1999) maintains that success depends on:

- the readiness of field office staff
- the extent of database availability
- access to the necessary technology (hardware and software)
- the degree of organizational commitment.

Figure 6-11. Position of Lead GIT Contacts in SFOs



Bobbe (2002) adds standards and guidelines and training and technical support to the list of items that have to be addressed in the implementation process. All these are unlikely to happen in an ad hoc manner with part-time attention to technology management of a person that performs other GIT tasks, or has other non-GIT responsibilities. The combination of responsibilities includes: organization/ coordination/administration (16); training (12); database (11); funding (7); policy development (5); technology - software/hardware (4); preparation of proposals (3); and other (12).

Finally, additional cross-tabulations are conducted to compare the data on key GIT contacts to the preceding analyses of the organizational approach (internal coordination within SFOs and type of internal focal point) and the level of GIT presence. The results suggest that:

- SFOs that have a GIT manager/staff or director/manager as the GIT contact also tend to have a focal point of internal coordination
- SFOs that have dedicated GIT staff, part time GIT staff, or GIT unit also tend to have a GIT person for their key contact
- SFOs with high GIT presence have either GIT person or director/manager for their key contact.

All those relationships are statistically significant and point to organizational middle management or professional staff level as the optimal group from which to designate key GIT contacts. Persons in high administrative positions and other personnel without close connection to either GIT activities or to an operational unit (department, section, or division) tend to be in SFOs with predominantly limited use of GIT. The involvement of high level administrators (in the case of SFOs, state foresters and deputy state foresters) needs additional clarification. While general support for GIT from administrators and decision-making entities is an important factor for successful implementation of GIT in organizational settings, having high level administrators in the role of key contacts may point to a gap in direct GIT management on a daily basis.

6.3 External Relations

Diffusion of GIT and proliferation of geographic data in digital format have prompted data exchange among numerous producers and users of such data. Data are often shared, but also sold for a fee that covers cost of data reproduction or, in some cases, generates additional revenue (Onsrud and Rushton 1995).

Data exchange activities require establishment of relationships within and outside organizations. They often draw on existing interactions, but also prompt new ones. In many cases those interactions within and between organizations become part of complex interorganizational processes. These go beyond data exchange to include, among many activities, coordinated acquisition, building, and/or maintenance of GIT databases, collaborative application projects, sharing of spatial data clearinghouses, and joint system development and use (Nedovic-Budic and Pinto 1999a, 1999b, 2000; Haithcoat, Warnecke and Nedovic-Budic 2001; Johnson et al. 2001).

Internal coordination in SFOs was discussed earlier in this chapter. SFOs also engage actively in relationships with other public and private organizations at federal, state, and local level. As shown in **Figure 6-12**, about half of them have ties with their parent organizations, the U.S. Forest Service, other state and federal agencies, state GI/GIT coordinators, and academic institutions. Fewer SFOs interact with local governments, NGOs, and private companies. No relationship is detected with

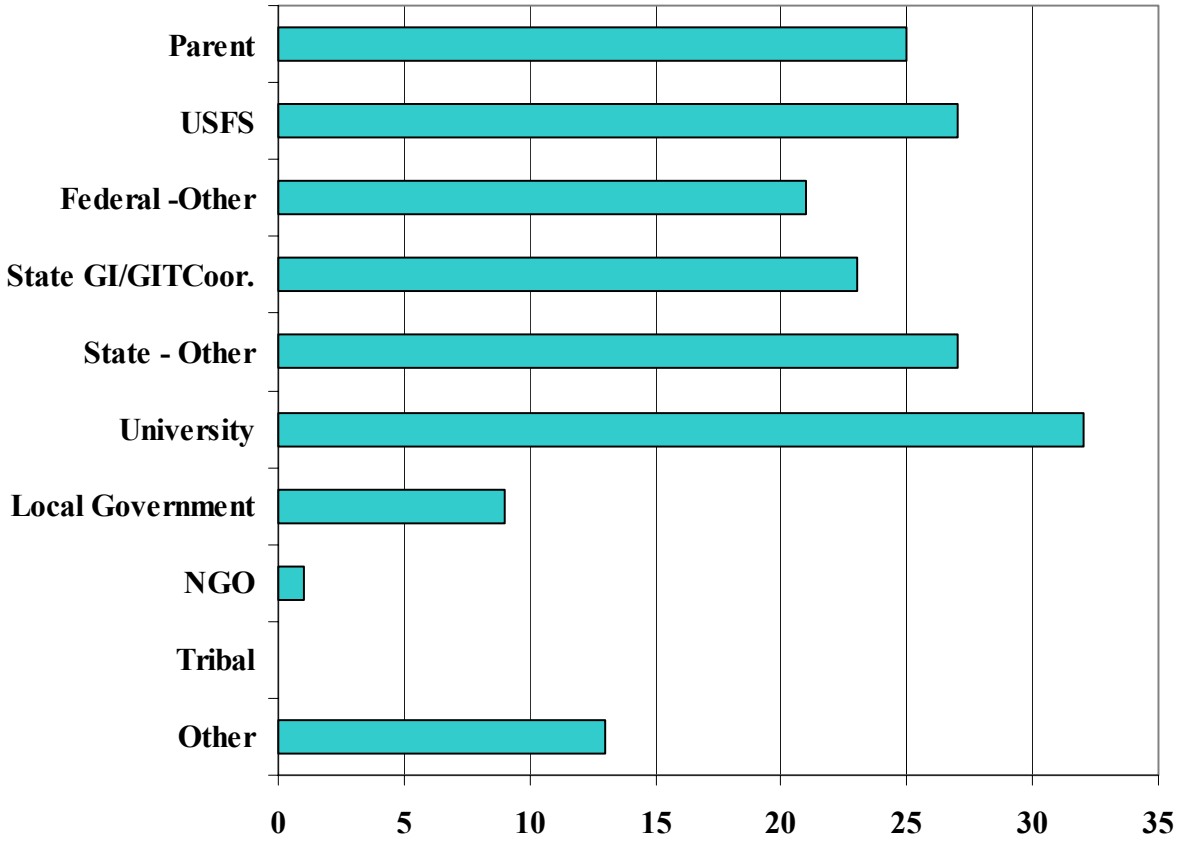
tribal governments. The majority of SFOs (40 or 90%) relate to more than one organization and/or group. The range is from one to seven, with a mean value of the number of relationships per SFO of 3.56.

Almost two thirds of the SFOs (32) indicate that they have relationships with universities. Academic institutions play an important role in supporting various aspects of SFO functionality and GIT needs. This involvement ranges from data acquisition and processing and development of forestry applications, to housing of SFOs (5 states, as discussed in Chapter 4). In the section discussing GIT assistance, ten universities are identified as a source of support and expertise, which imply even closer relationship with the SFOs.

SFO relationships with their parent organizations, parental groups, state GI/GIT coordinators, and statewide GI/GIT groups are of important concern. The incidence and authorization of the statewide GI/GIT coordinators is discussed in chapter one, with only four states not having an authorized or informal coordination entity.

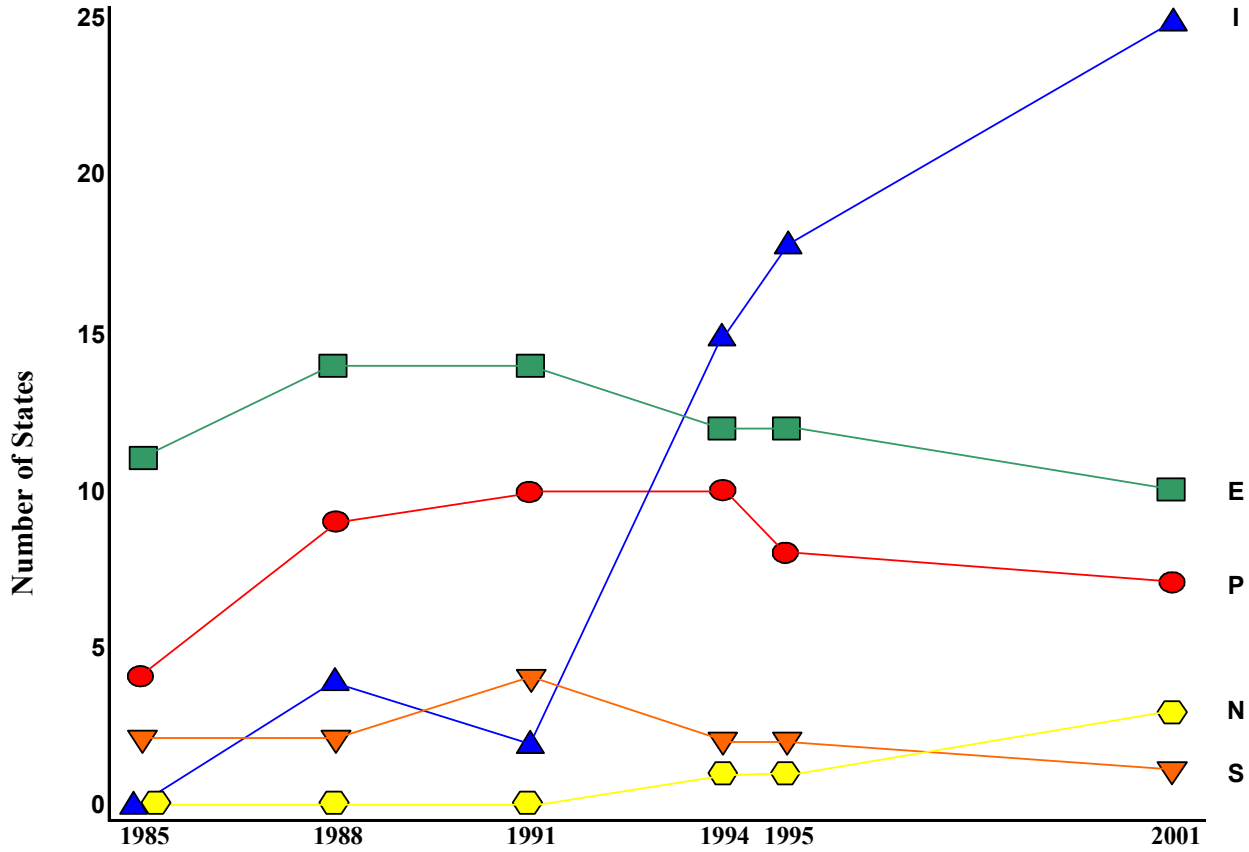
Figure 6-13 illustrates the change in the administrative location of state GI/GIT coordinators from 1985 to 2001. The organizational typology includes five distinct

Figure 6-12. SFO Relationships by Organizational Type



administrative locations in which state GI/GIT coordinators may reside. The first two categories, Planning, Policy or Administration (P), and Information or Information Technology (I), represent central agencies with a statewide focus, which exist in most or all state governments. The third category, Environment and Natural Resources (E), includes various comprehensive or other agencies whose mission includes one or more ENR functions, and may include the SFO. While these categories include most state GI/GIT coordinators, some entities are located in other state government agencies (S) than those described above, or outside state government itself (N).

Figure 6-13. Administrative Location of State GI/GIT Coordinators



Key

P	=	**Planning, Policy, Budget, or Administration Agency**
I	=	**Information Policy or Technology Agency**
E	=	**Environmental or Natural Resources Agency, including Geological Survey**
S	=	**Other State Government Agency**
N	=	**Non-State Government Organization**

Over the 15-year period shown in the figure, the trend toward increasing roles of state information policy or technology agencies is evident and due to both the location of newly established coordination offices within them and the transfer of existing offices from other organizations. Several advantages and disadvantages have been identified in locating a GI/GIT coordinator in an information agency (Warnecke et.al. 2002).

Despite the trend toward locating state GI/GIT coordinators within information agencies, their presence in planning and environmental and natural resource agencies is still significant. While the history of state information agency involvement in GI/GIT is rather recent in states, some planning agencies initiated GI/GIT efforts before 1980, as in Maryland, Minnesota and New York (Warnecke 1998). Similarly, some of the environmental and natural resource agencies, particularly those with strong natural resources missions, were among the earliest locations of GI/GIT activities and coordination roles in the states, such as in California, Idaho, Illinois, Texas and Washington. Today, some of these agencies have the largest and most advanced GI/GIT operations of any type of state organization, though their role as statewide coordinator may have been replaced by another state organization. While some of these agencies with strong GI/GIT efforts may serve as parents to SFOs, the involvement of SFOs in these activities varies.

More extensive discussion about the relationship between SFOs and their parent organizations is provided in chapter 4. The intersection between the organizational home of GI/GIT coordination offices and SFO parent organizations is presented in **Figure 6-14**. The figure reveals the pattern between the organizational contexts of

Figure 6-14. Location of the Primary State GI/GIT Coordinators and SFO Parents by Type

	Location of State GI/GIT Coordination Office						
Parent Type	**P**	**I**	**E**	**S**	**N**	**N/A**	**Total**
Natural Resources	**5**	**7**	**4**		**3**	**2**	**21**
Agriculture	**1**	**3**	**1**			**1**	**6**
Environment & NR	**1**	**3**	**2**				**6**
Lands		**1**					**1**
Commerce			**1**				**1**
University		**5**					**5**
Commission		**2**	**1**	**1**		**1**	**5**
Alone		**5**					**5**
Total	**7**	**25**	**10**	**1**	**3**	**4**	**50**

P = Planning, Policy, Budget, or Administration Agency
I = Information Policy or Technology Agency
E = Environmental or Natural Resources Agency, including Geological Survey
S = Other State Government Agency
N = Non-State Government Organization

SFOs and state GI/GIT coordinators. For example, of 27 SFOs under environmental and natural resource organizations, only 6 have their state GI/GIT coordinators located under the same structure. For all of the independent SFOs (labeled as "alone") and all university-based SFOs, the statewide coordinators are under information technology agencies, while the coordinators are located in various organizations if the SFO has a forestry commission. Overall, there is very little coincidence in the substantive areas of organizations housing SFOs and statewide GI/GIT coordinators, which may be an indicator of potential difficulties in communicating organizational needs and interests. However, this general observation is expected to manifest itself differently in individual cases, depending on many additional internal and external organizational factors and circumstances.

Further evaluation of the extent of relationships pursued by the SFOs is based on a qualitative estimate of the intensity, frequency, and nature of contacts between the SFOs and a) their parents; b) parent GIT groups; c) state GI/GIT coordinators, and d) statewide GI groups. The extent of these relationships is coded as high, medium, low, and none. **Figure 6-15** displays the counts and percentages for the various relationship types and extents.

The primary and more intensive relationships that SFOs maintain are with parent organizations and statewide GI groups. About half of the SFOs relate well to both. Participation in statewide GI groups varies from active involvement in policy making and exchange of information, to formal agency representation by a staff member. Agency representatives engage in statewide GI group activities at various levels, from attendance at committee meetings to significant participation in development of policies, guidelines, standards, and financial contributions toward statewide datasets. Relationships with state GI/GIT coordination offices are less frequent and less intensive. Some examples that illustrate how SFOs are involved in statewide GI/GIT activities are discussed below as drawn from the state profiles in Appendix C:

Figure 6-15. Extent of Relationship with Parents and Coordinating Offices and Groups (N=50=100%)

	Parent		Parent Group		State GI Coordinator		Statewide GI Group	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
High	18	36%	5	10%	11	22%	14	28%
Medium	9	18%	0	0%	6	12%	16	32%
Low	1	2%	1	2%	6	12%	5	10%
None	1	2%	0	0%	0	0%	0	0%
N/A	10	20%	10	20%	4	8%	1	2%
Unknown	11	22%	34	68%	23	46%	14	28%

- The Arkansas Forestry Commission (AFC) works with the state Geographic Information Office and the Center for Advanced Spatial Technologies (CAST) on many statewide GIT matters. For example, AFC provides personnel for in-the-field verification of GAP data layers. Arkansas currently has two groups dedicated to coordinating GI/GIT in the state, led by the Arkansas State Land Information Board (SLIB). The SLIB is complemented by the Arkansas GIS Users Forum, which was the first GI/GIT group in the state as it was formed in 1990. AFC also works with the SLIB and the Forum by cooperatively identifying state agency needs and the resources required to complete projects, coordinating efforts for in-common projects, and acquiring funding.

- Statewide GIT coordination and information is provided by Maine's Office of Geographic Information Systems (MEGIS). Maine has several groups important to statewide GI/GIT coordination, including the Executive Council for GIS (GIS EC), which oversees the operation of MEGIS and development of a statewide GIS. A GIS Technical Committee and various subcommittees aid the Council. In addition, a GIS Steering Committee was established by statute in 2001 to help design an approach to assist municipalities in developing and using GIS to track development and promote smart growth. The Maine Forest Service (MFS) GIS Coordinator participates in technical subcommittee meetings relating to forestry issues and other statewide efforts in time available.

- In Minnesota, the Land Management Information Center (LMIC) is the lead state GI/GIT coordination entity. Minnesota Governor's Council on Geographic Information (GCGI) is the primary state coordinating group. It helps promote coordinated and efficient development of GIT within Minnesota. An additional group is the GIS/LIS Consortium, which is a nonprofit organization established in 1988 in response to growing GIS use within Minnesota. The Division of Forestry works with LMIC directly in the course of daily operations and with the GCGI indirectly, since its parent, the Department of Natural Resources, is a member.

- The Mississippi Automated Resource Information System (MARIS), which is administered through the MARIS Technical Center (MTC), serves as the lead for GI/GIT in state government and as a statewide service center for GI/GIT including satellite imagery. The Mississippi Forestry Commission (MFC) contracts and works with MARIS to develop GIT for many forestry applications. MFC personnel regularly attend MARIS advisory committee meetings and provide input as necessary.

- In Oregon, the official state GI/GIT lead office is the Office of the Statewide GIS Coordinator, located in the Information Resources Management Division (IRMD) of the Department of Administrative Services (DAS), which serves as the information policy and technology division for DAS. The Oregon Department of Forestry (ODF) acquires data from this and other agencies, as well as Oregon State University. ODF actively coordinates activities with the Oregon Geographic Information Council and the Statewide GIS Coordinator, and participates on OGIC to resolve GIS policy issues.

- The Virginia Geographic Information Network (VGIN) is the official lead statewide organization in the Commonwealth for GI/GIT. Virginia's two most prominent coordination groups specifically addressing statewide GI/GIT

coordination are the Virginia Geographic Information Network (VGIN) Advisory Board and the Virginia Association of Mapping and Land Information Systems (VAMLIS). The Department of Forestry's (DOF) GIS Manager participates in VGIN's Natural Resources Managers Workgroup, a group designed to give VGIN guidance about data and technology priorities for those agencies working in natural resources fields. DOF also submits metadata about DOF-generated GIS layers to VGIN's metadata clearinghouse. Whenever possible, DOF participates in GIT education and outreach events sponsored by VGIN.

- The Department of Natural Resources (DNR) is the state forestry organization in Washington. Statewide GI/GIT coordination roles are shared by the Department of Information Services (DIS) and DNR. Neither one has been specifically authorized to serve as the official lead for GI/GIT in the state, though DNR was designated by the Legislature as the lead state agency in state government to develop a "statewide base mapping system" in 1973. The Washington State Geographic Information Council (WAGIC) has been the lead statewide GI/GIT voluntary group since it was created by the director of the Department of Information Services (DIS) in 1990 to serve as a policy and coordinating forum for GI/GIT in the state. DNR has been an active participant in, and at one point chaired WAGIC, and also actively participates in several interagency data development projects.

- Two Wisconsin organizations that serve in statewide GI/GIT coordination roles are the Office of Land Information Services (OLIS) and the State Cartographer's Office (SCO). Several groups specifically address GI/GIT; however, the Wisconsin Land Information Board (WLIB) serves as the lead GI/GIT group in the state and manages a multi-million dollar program that provides funding to counties to manage GI. The Wisconsin Land Information Association (WLIA) is a private, non-profit, grassroots organization of professionals, including individual, corporate, and non-profit members. The Division of Forestry is connected to the state GI/GIT infrastructure through its parent, the Department of Natural Resources (DNR) and participation in WLIA.

Information about SFO interaction with parental groups is sporadic in the profiles. Several SFOs did not indicate whether or not their parent has a GI/GIT coordination group. If existent, the relationships seem to be close. It is important to note that of the 40 SFOs with parents, only a few have groups that encourage internal exchange of GI/GIT information and experiences. Many SFO parents are members of statewide GI groups, and in some cases they provide an administrative home for a statewide GI/GIT coordinating entity. Those links between parents and statewide entities may not have much effect on SFOs if the channels of communications within parent organizations and groups are not well institutionalized and functional. This lack of opportunity for internal communications concerning GI/GIT seems to be common across many SFOs and their parents. If SFO parents are not adequately aware of SFO needs and issues, then it may lead to weak representation of SFOs' needs and interests in broader statewide forums.

Some examples exist in which parental GI/GIT groups are established and respective SFOs participate in them:

- Florida has no official statewide GI/GIT coordinating office or group at this time, but coordination of GIT activities occurs within the Department of Agriculture and Consumer Services (ACS), the parent of Florida's Division of Forestry, through a GIS Users group.

- The Michigan Department of Natural Resources (DNR), which houses the Forest, Minerals, and Fire Management Division (FMFM), has an inter-divisional GIT coordinating group, the Virtual Geographic Information Laboratory (ViGIL). ViGIL directs the Spatial Information Resource Center, which provides GIT support to DNR field staff. ViGIL also solicits GIT project proposals from DNR staff and advocates these projects through the Department budget process.

- The New York Division of Lands and Forests, located in the Department of Environmental Conservation (DEC), is not active in statewide groups, but its staff attends quarterly DEC GIT coordination meetings. An additional coordinating effort is the Metropolitan New York I-Team, which has been developed to link GIS activities between New York City and the surrounding counties in New York State and New Jersey, though the SFO has not been active in this effort.

The type and extent of SFOs' relationships with various federal, state, and local groups are cross-tabulated with the level of GIT presence to explore the possible effects of such relationships on GIT use. The contingency tables are statistically significant with:

- SFOs that interact with state GI/GIT coordination offices (Pearson Chi-square test significant at 0.26 level), and in particular with a higher extent of such interaction (Pearson Chi-square test significant at 0.044 level)
- higher extent of interaction with parent groups (Pearson Chi-square test significant at 0.033 level)
- higher extent of interaction with statewide coordination groups (Pearson Chi-square test significant at 0.04 level).

For example, out of 21 SFO GIT users classified as active, 15 or approximately three-fourths have ties to their state GI/GIT coordinator; while only about one-fourth of limited and medium level GIT users (six out of 22) have a similar relationship established. Further, out of 28 active and advanced GIT users, 19 of them interact with four or more other organizations; conversely, out of 22 low and medium level GIT users, only seven have such a high number of relationships established. Those relationships are similar, but even more statistically significant, when calculated against GIT presence reduced from four levels (advanced, active, medium, and limited) to a categorical variable with two values (high and low). These results contribute important insight about the value and effectiveness of coordination entities at the state level.

No statistically significant relationship is detected between the level of GIT presence and relationships with parent organizations, U.S. Forest Service, other state and federal agencies, local organizations, and universities. This indicates that the level of GIT use in SFOs varies regardless of their engagement with the entities listed above. However, the state profiles include several excellent examples of how SFOs collaborate with the U.S. Forest Service, which is particularly evident for specific applications or projects.

6.4 GIT Policies, Issues, and Benefits

Implementation and use of GIT involves a complex set of activities needed to manage technological capacity, data, human and financial resources, timing, and the process of organizational change (Budic and Godschalk 1994, Huxhold and Levinsohn 1995). Establishing policies to guide the development and use of GIT is one of the most crucial elements of the overall process of planning and incorporating GIT in an organizational setting.

However, only six SFOs report having GIT policies.

Documents from the Oregon Department of Forestry (ODF) and California Department of Forestry and Fire Protection (CDF) are used to illustrate the comprehensive scope of GIT policies. ODF's *GIS Operation Manual*, published in the summer of 2000, includes the following themes organized into chapters:

- GIS Coordination (including departmental, program and district coordination points)
- GIS Information Exchange (e-mail, roundtables, conference, strategic plan, directive, operations manual, and web pages)
- GIS Data (class, designation, and stability; catalog; maintenance procedures; and standards)
- GIS Software/Hardware
- GIS technical competency, education and integration (primarily dealing with training options)
- Other Related Issues (GPS and RS)

The Department's *GIS Strategic Plan* adopted in 1996, presents the guiding principles for GIT implementation and use. Among other points, the principles include:

- commitment to coordination internally and whenever possible with external partners and stakeholders
- use of GIS as strategic, operational, and communication tool requirement for GIS budgeting; public access.

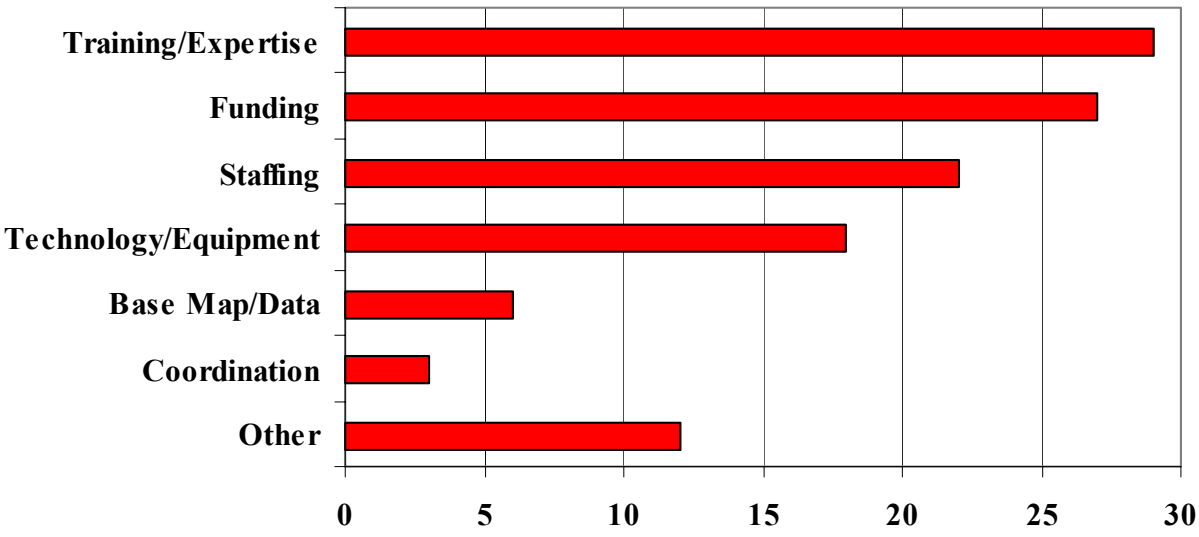
Section 16, *GIS Architecture,* of the CDF's draft Enterprise Architecture Plan is a general introduction to GIS technology as it evolved in the Department since 1987. The document includes principles and recommended best practices in six areas: governance, data management, enterprise GIS, desktop GIS, professional GIS, and web based GIS. Among the many themes included in the draft document are: Monitoring of new spatial technologies and technological integration; coordination and collaboration; management of implementation process; legal liability; provision of public information; statewide standardization and "framework" developments; roles and responsibilities; enterprise system and distributed data environment; data sharing; advanced applications; validation of system design and user needs; and technical support for desktop GIS.

Policy documents and plans like those from California and Oregon are developed to enable a systematic and comprehensive view of the issues and challenges encountered in the GIT implementation process, and to provide a general framework and direction for solutions to those issues and challenges. Such guidance is important for agencies at both initiation and advanced stages of GIT use. SFOs with both high and low presence of GIT reported implementation obstacles and challanges. **Figure 6-16** shows training/expertise and funding as of the two most common problems reported by over half of SFOs. General staffing and technological issues are also considerable.

Cross-tabulation between GIT presence and various issues reported by SFOs is insignificant for all variables except for funding (significant at 0.014 level). Not surprisingly, SFOs with more limited GIT use report funding problems more often. Out of 27 SFOs that mention the funding issue, 16 are limited GIT users and 11 are advanced GIT users. Out of 21 SFOs that do not cite funding as a problem, 16 are advanced users and five are limited GIT users. Funding issues relate to other issues directly, as many agencies specify staffing, hardware and software, and data items for which funding is needed.

Coordination is reported by only three SFOs. However, such low responses are unusual

Figure 6-16. GIT Issues



compared to other related research. Coordination typically is a major issue, but this low number of SFOs reporting it may result from the overwhelming importance of the issues that are mentioned more frequently (eg. funding and staffing).

GIT implementation issues and pitfalls have been acknowledged for over a decade -- since early GIT implementation efforts in forestry organizations -- but many of them still persist. For example, Jordan (1991) lists the following pitfalls encountered in forestry organizations:

- Failure to identify the users
- Failure to involve managers and users, as well as technocrats
- Failure to match GIS capability and needs
- Failure to identify total costs
- Failure to conduct a pilot study
- Giving GIS implementation responsibility to data processing department
- Failure to consider technology transfer

On the other end of the spectrum from GIT issues and problems are the benefits from GIT implementation. The impact of GIT can be evaluated based on the following criteria: system quality, information quality, information use, user satisfaction, individual (decision-making) impact, and organizational performance (efficiency and effectiveness) (Nedovic-Budic 1998, 1999). Available empirical evidence suggests that major benefits are easily achieved in the area of data processing and productivity, but that decision-making and public service benefits are slower to achieve.

Though not a specific subject of query, SFOs volunteered information about GIT benefits. Eight of them report that increased efficiency is the main benefit they experienced from the use of GIT; while 11 report effectiveness and decision-making benefits; and eight report other benefits. The SFOs refer to a variety of ways in which they experience benefits and describe them in more specific terms. For example, efficiency is experienced in program administration (e.g., securing of funding – grant

applications, best management practices, and general management of forest and wildlife), generation of maps, access to data, improved data accuracy, and field data acquisition.

GIT is an important communication and visualization tool used to facilitate decision-making and policy making process in many SFOs. Consideration of social and political processes may be insured through the use of GIT. Inclusion of socio-demographic variables and provision of public access to data are two ways of facilitating this potential role GIT might have in the public arena (Smith et al. 1995).

SFOs also indicate that emergency management, response, and recovery are functions that expect a lot from GIT. Respondents to the GIS survey conducted in 1993 with the National Association of State Foresters (Warnecke and Herrington 1994) provide a similar range of benefits.

In summary, the preceding review of the organizational approaches, institutional issues, and management factors relevant in the process of GIT implementation, reveals a diversity of experiences and practices in SFOs. With GIT diffusion among those organizations in a fairly advanced stage (particularly for GIS) and with the extensive set of forestry applications of GIT, the non-technological issues come into the foreground as the main determinants of success and utility of GIT.

The non-technological themes included in this chapter focus on the organizational approaches to GIT use, GIT staffing in headquarters and field/regional offices, coordination of GIT activities with internal and external entities, relationships with parent and other organizations and groups, and GIT policies, issues, and benefits. Overall assessment of the SFOs on these themes reveals a user group that is active and enthusiastic about GIT use, but which still lacks organizational structure that would allow it to take full advantage of the three technologies considered – GIS, GPS, and RS.

First, the majority of SFOs pursue an individual approach to GIT implementation and use. Enterprise approaches that support organizational missions and functions in a comprehensive and integrated manner are seldom employed, although these advantages are well recognized.

Second, there is a clear intent among most SFOs to provide internal expertise, coordination, communication, and management. The middle management level seems to be the best location for key GIT contacts and coordinators. However, few of the GIT contacts and personnel are fully dedicated to GIT. GIT contacts often have difficulties in balancing their GIT and other non-GIT activities.

Third, assistance is sought and available from outside agencies, primarily from the SFOs' parents and early in GIT implementation. Other forms of more advanced relationships and assistance in data development and applications are also pursued with a variety of organizations, including universities, U.S. Forest Service, and other federal and state agencies, but almost none with local governments. The analyses point to dedicated staffing in headquarters and intensive contacts with state GI/GIT coordination groups and offices as the most effective entities for enabling diffusion and growth of GIT in SFOs. Finally, the results suggest that many obstacles influence institutionalization of GIT in SFOs. Lack of professional expertise, staffing, training, and funding are the most common challenges to GIT developers and users.